THE ECONOMICS OF TEACHER OCCUPATIONAL CHOICE

IN CHINA

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ABSTRACT

The Economics of Teacher Occupational Choice in China

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Teachers are central to improving education quality and student learning. Yet, it is common that education systems short-pay teachers. Linking the occupational choice literature, this dissertation raises concern regarding potentially large adverse effects of holding teacher wages back from broader market levels, in terms of declining teacher aptitude and reduced student learning. Using a four-part analysis, I examine and contextualize theoretical stipulations using the case of Chinese teachers. Firstly, in Part I, I establish the causal link between teachers' human capital level and student learning outcomes, by employing student fixed-effect models to relate differences in teachers across subjects to variations in student test scores. I find statistically significant impacts of teachers holding advanced tertiary degrees on improving student learning, at 0.033 standard deviations or adding about 1 additional month of learning over a typical 9-month academic year. Secondly, in Part II, I document relative pay gaps between teachers and comparable workers using Mincer earnings function. Between 1988 and 2013, I find sharp shifts in the relative wage attractiveness in the teaching sector, such that teachers' mean wage levels experienced 24 percentage-points reversal, at 11 percent below the private sector levels in 2013. Also, returns to holding advanced tertiary degrees in teaching is about 11 to 15 percent less than that of the private sector in years 2007, 2008, and 2013, while this difference was statistically indistinguishable in the pre-2007 period. Thirdly, in Part III, I estimate the probability of entry to teaching by different human capital traits, and find declining trends for more educated individuals overall. In 2007 and 2013, new labor market entrants with

advanced tertiary degrees are 4.7 and 5.8 percentage-points less likely than comparable workers in older cohorts to choose teaching. Similar patterns continue to hold when I use alternative human capital and skills proxies. Fourthly, in Part IV, using a national representative panel dataset containing 211 matched teachers, I track career destinations and relate it to opportunity wages and non-pecuniary outcomes. In general, I find that teacher turnover rates are high at about 35 percent, half of which are exits from the education sector entirely; there also exist positive associations between opportunity wage levels and turnover decisions, but there is no evidence of non-pecuniary gains from turnovers.

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DEDICATION

I dedicate this dissertation to my parents,

and

In memory of my loving grandparents, I miss you.

Chapter I

INTRODUCTION

1.1 Problem and Statement of Purpose

Education quality is a frequent topic of discussion among parents, educators, and policy makers, and there is a growing consensus that the quality of teachers holds central weight to making substantive progress in improving education. Notably, teacher quality is often cited as the single most important school factor affecting student learning and achievement (Glazerman, Loeb, Goldhaber, Staiger, Raudenbush, & Whitehurst, 2010; Hanushek & Rivkin, 2012), with lasting impacts for students well into adulthood (Chetty, Friedman, & Rockoff, 2014). To this end, scholars and policy makers tend to focus on three commonly perceived approaches to improving teacher quality: attracting the best and brightest individuals, incentivizing teachers to better their performance, and offering professional development opportunities for continued improvement (Jackson, 2012). While each of these broad typologies of intervention is critical in its own regard and undeniably intertwined in many ways, recruitment and retention of talented teachers emerges as the cardinal gateway in realizing overall teacher quality improvement. In fact, it has been widely recognized as one of the most important factors in ensuring equitable and quality education for all students (Moore, Destefano, Terway, & Balwanz, 2008; UNICEF, 2011).

Nonetheless, a broad range of studies has indicated that education systems persistently fail to attract the brightest and most productive individuals to become teachers, putting the improvement of education quality in jeopardy. For one, earlier studies conducted by Vance and Schlecty (1982), Weaver (1983), Hanushek and Pace (1995), Ballou and Podgursky (1997) documented that the average teacher's math and verbal aptitude, as measured by college entrance test scores, has been on a steady decline. Likewise, more recent clusters of research continue to confirm these observations; for instance, Corcoran, Evans, and Schwab (2004), Lakdawalla (2006), Bacolod (2007), and Richey (2014) all present similar evidence on the falling aptitude of teachers in the U.S. context. In the same vein, cross-national comparisons also show that in almost all countries, youth who aspire to become teachers are those who perform below the national average on cognitive assessments (Bruns & Luque, 2015). Extreme cases even show that in some instances students in upper primary grades often outperform their teacher on subject knowledge (UNESCO Institute for Statistics, 2006).

While most governments acknowledge the importance of investing in human capital, a main logistical constraint facing most countries is ensuring consistency and quality in the supply of teaching staffs (World Bank, 2006). In this regard, how well teachers are remunerated for their time and dedication to improve student learning to a large extent determines the attractiveness of the profession, and whether talented individuals are reasonably expected to pursue it. Existing research in the United States and beyond has demonstrated that relative shifts in salary structures substantially influence teaching force quality through individual occupational choice decisions (see Figlio, 1997; Bacolod, 2007; Nagler, Popiunik, & West, 2015). Yet, little is known about this relationship in emerging economies, especially in the case of China, where contextual factors such as wage growth and sectoral income inequality are much more pronounced than in high-income countries.

1.2 Teacher Quality: Taking a Systemic View

The importance of teachers for students, schools, and education systems cannot be emphasized enough. Rigorous research in the United States have shown that students can learn as much as three times more with a high quality teacher as opposed to studying with a less effective teacher in a given school year (Rockoff, 2004). To add, this relationship has been shown to be even more evident in low- and middle-income countries (Bau & Das, 2017). To further substantiate the magnitude of the impact of teachers, Rivkin, Hanushek, and Kain (2005) and Jackson (2010) show that exposure to better teachers are categorically more influential than attending a better performing school, and matters more for student learning achievement. In addition, there are also potentially large spillover effects from having better teachers, such that more effective teachers not only improve the learning outcomes of her students, but are also shown to advance the learning of her colleague's students (Jackson & Bruegmann, 2009). Moreover, recruiting certain underrepresented teacher types, such as women in traditionally male-majority STEM subjects, can have substantial influence on how students of those underrepresented groups are motivated, perceive and engage learning (Eble & Hu, 2018). Yet, given the evidence on the strong influence of teachers to student learning, most education systems are facing tremendous difficulties in filling teaching posts with candidates who are prepared and ready to teach (World Bank, 2017).

To put simply, the world today is facing a global crisis to staff schools with talented, high quality and dedicated teachers, and in particular short supply are those with strong backgrounds and scholastic aptitudes in both subject and pedagogy knowledge (Schleicher, 2012; Organisation for Economic Co-operation and Development, 2013). However, improving teacher quality is a multi-dimensional issue that requires holistic evaluation at the system-level. For instance, many teacher education programs are often poorly funded or designed, and result in minimal instructional and career preparation for candidates who do decide to pursue teaching (Levine, 2006). To further exacerbate the issue, support services are either not in place or mismatched when teachers enter the profession, leaving many new teachers to report a lack of instructional and professional support which hinder instructional effectiveness (Ingersoll & Smith, 2003; Struyven & Vanthornout, 2014; Simon & Johnson, 2015). When all of these factors are compounded, the consequences are that many teachers reveal being underpaid, overworked, and at the brink of burnout (Ingersoll & May, 2012; Schonfeld, Bianchi, & Luehring-Jones, 2017; Luchei & Jeong, 2018). All of the above complex and intertwined system-level issues, while beyond the scope of this dissertation, can help shed light and lend useful perspective to the multifarious challenge impeding the improvement of teacher compensation as an effective means for recruiting and retaining talented individuals.

To this end, systemic concerns about teacher recruitment, training, and retention coincide with the empirical observation that the size and quality of available teachers has substantially declined. In developed economies, there has been a long standing consensus that college graduates with strong academic skills and teaching preparedness are less likely to enter teaching careers (Vegas, Murnane, & Willett, 2001). In response, studies have drawn the link between career attractiveness with competitive salary and desirable working conditions. For instance, the Organisation for Economic Co-operation and Development

(2016) has shown that primary school teachers are on average paid 81 cents to the dollar compared to a typical tertiary-educated worker, while secondary school teachers receive between 85 to 90 percent of the same benchmark. In many parts of the developing world, similar chronic issues with low compensation and poor working conditions continue to plague the teaching profession. As case in point, in post-socialist regions in Central Asia, teacher salaries are not only low, but trails well behind the national average wage, ranging from 53 to 92 percent of what individuals with comparable educational attainment can expect to earn (Steiner-Khamsi, 2007; Steiner-Khamsi, 2012). To add, teachers are often burdened with heavy teaching loads and unpredictable take-home pay due to outdated salary structure arrangements that set base salaries arbitrarily low, and over-reliance on a "broken system" of salary supplements which were often not paid in full (Steiner-Khamsi, 2016a, p.17). These findings not only raise concerns regarding how to best attract well prepared teachers, but more importantly pose policy-relevant queries in relation to addressing broader educational inequity as teacher recruitment and retention challenges are often the hardest to tackle in underserved, underfunded, and marginalized communities.

While raising teacher salary is necessary and effective in improving teacher retention (Hendricks, 2014), improving teacher compensation often requires raising large sums of capital, both in terms of economic funds as well as political determination. For example, in most countries, personnel procurement expenditure represents more than 80 percent of national education budgets (Levin, 2010), which leaves little room for all other educationally important learning inputs, such as instructional supplies, facility upkeep, individualized attention for students from disadvantaged backgrounds, and high-quality teacher professional development activities. To further complicate matters, many critics of public education have taken issue with teachers, citing low educational performance as a key reform justification that aim at weakening teacher unions (Peltzman, 1996; Rose & Sonstelie, 2010; Strunk, 2011), removing job securities such as teacher tenure (Rockoff, Staiger, Kane, & Taylor 2012), installing stronger accountability monitoring (Goldhaber & Hansen, 2008; Eckert & Dabrowski, 2010), and linking up student performance to teacher pay (Muralidharan & Sundararaman, 2011; Lavy, 2016).

Given the importance of teachers and noting the complication that improving teacher quality involves many moving parts in both policy and praxis, much deeper research is needed in shedding light to our understanding of how teacher occupational choice can be leveraged in educationally meaningful ways. In this light, it is vital to acknowledge that the difficulty in recruiting and retaining good teachers is systemic, but if left unaddressed, will inevitably create a development gap that jeopardizes vast efforts to improve education attainment and quality worldwide – how can students learn without good teachers in the classroom?

1.3 Research Purpose and Questions

In virtue of the global challenge to staff schools with bright and qualified teachers, this dissertation situates itself within the teacher quality literature with broader connections to occupational choice theory, and is concerned with understanding how the ability distribution of the teaching force shifts over time, what factors contribute to such change, and consequences on student learning. The main research objective of this dissertation is to understand how sectoral wage characteristics influence teacher occupational choice, labor supply, and evaluate its relevant consequences on student learning. While this dissertation focuses on the specific case of China, its analytic context is relevant for all developing countries that aspire to better understand teacher composition and quality through an occupational choice lens. By drawing on both horizontal and vertical comparisons of teacher wages and quality, and engaging in a meaningful investigation on a critical topic, I hope to augment the relevance and comparability of teacher occupational choice. Throughout the dissertation, I use "occupational choice" to refer to between-sector choice, unless otherwise noted. As such, I use "between-sector occupational choice" and "occupational choice" interchangeably. Conceptually, between-sector choice is closely in line with teacher recruitment and retention literature, whereas within-sector choice centers around studies on job match and mobility. In general terms, the between-sector choice literature is interested in self-selection effects that attract high ability individuals to a particular sector, while within-sector choice is interested in the quality of match effects that result in productivity and income gains from improved worker-firm match.

The occupational choice theory literature, galvanized by the seminal work of Andrew D. Roy (1951), is interested in how individuals pursue their comparative advantage in the labor market. Economic studies have documented extensively on how individuals, in choosing to enter one market over another, are affected by differential conditions (see Willis and Rosen, 1979; McElroy and Horney, 1981; Lazear, 1986; Borjas, 1987). In teacher labor markets, differences in the distribution of wage returns between teaching and non-teaching jobs are reasonably expected to influence individual career decisions. For instance, suppose that wage structure for teaching jobs remains relatively stagnant, while wage dispersion in non-teaching jobs rises substantially. In this case, new workers who belong in the high ability group (i.e. motivation, cognitive skills, social skills, academic preparation) would have a lower return to high ability in the teaching sector, and thus become less incentivized to enter the teaching sector. At the same time, current teachers who belong in high ability groups would have increased incentives to leave teaching for non-teaching jobs, pursuing higher human capital and skill premium. As a general prediction, relative changes in wage structure can influence both labor supply decisions as well as the ability sorting patterns between teaching and non-teaching sectors, which have serious implications for the overall quality of the teaching force, and thereby subsequently affecting education quality and student learning.

In each section of the dissertation, I tackle a thematic set of research questions pertaining to teacher occupational choice. To begin, I first motivate this dissertation by relating traditional measures of observable teacher characteristics to the amount of contribution teachers have on student learning outcomes (Part I). Secondly, I compare teachers to comparable workers outside of the education sector, and document adjusted wage profiles and compensation gaps over time (Part II). Thirdly, I investigate how teachers compare to non-teachers using different measures of human capital (Part III). Finally, I explore the incidence of job turnover for teachers and examine its relationship with relative wages in comparable careers, as well as its impact on non-pecuniary labor market outcomes (Part IV). In more detail, I explore the following research questions in each section:

- **RQ#1:** What is the relationship between observable characteristics of teacher labor quality on student learning outcomes?
- **RQ#2:** How large is the teaching wage penalty between workers in teaching and non-teaching sectors, after accounting for individual characteristics?
- **RQ#3:** How has the relative quality of teachers, compared to similar workers in other sectors, evolved in the past decades?
- **RQ#4:** What is the incidence of job turnover for teachers in China? What is the influence of non-teaching opportunity wage on occupational decision?

Importantly, this dissertation is intended to contribute to the existing literature in several ways. First, this dissertation rigorously documents the magnitude of teacher-to-non-teacher wage gap in a large developing country, China. Second, I relate the findings on teacher wage gap to observations of teacher ability trends, and examines occupational choice theory in a teacher labor market context. Third, I employ econometric methods to estimate causal impact of observable teacher quality on student learning, and explore consequences of relative wage effects on teacher job turnover decisions. Fourth, this dissertation aims to expand the scope of scholarly discussion in the field of comparative and international education, with respect to theory, context, and methodology.

Chapter II

LITERATURE REVIEW

2.1 Contextual Background

In past decades, China has made significant progress in both economic and social development. For one, China’s GNI per Capita has risen substantially, and is expected to continue to increase at a faster rate than other regional developing countries in East Asia and the Pacific Region (World Bank, 2012). For another, as a composite measure of social welfare in a country, China's Human Development Index (HDI) rose by 2 percent annually from 0.410 to 0.700 between 1980 and 2012, placing China above the regional average of 0.683. (United Nations Development Programme, 2013). More specifically in the education sector, China has achieved near-universal net enrolment for primary education at 99.8 percent in 2011 (Ministry of Education, 2011), and continues to expand access to secondary and tertiary education throughout the country. In this regard, education has been effectively mitigating the multidimensionality of inequality and marginalization in China, and serves as one of the most important channels through which core objectives of the social welfare systems have been materialized in China (Gao, Yang, Zhang, & Li, 2018). However, a remaining concern for the future of education development in China lies in improving educational quality and equity, as stated in the country’s guidebook for future education polices, *National Plan for Medium- and Long-Term Education Reform and Development (2010–2020)*, which identifies ‘shortage of talented and quality teachers’ as a main constraint for furthering education development (State Council, 2010, Chapter 17).

2.11 The Education System in China

The schooling system in China is one of the largest in the world, and employs one of the largest teacher labor force. The structure of the Chinese education system adopts a “6-3-3” organization framework, which provides 6 years of primary education, 3 years of junior secondary, and 3 years of senior secondary education. The compulsory education period covers the first 9 years in the system and is mandated by law. While the broader population continues to experience demographic transition, student enrollments in primary, lower and upper secondary schools has reached a combined 175 million students in 2010 (see Table 2-1 for detailed breakdown by level of instruction). In 2012, approximately 5.6 million teachers taught in primary schools, and approximately 3.4 million teachers were employed in lower secondary schools, totaling close to 10 million teachers employed in primary and lower secondary schools (Ministry of Education, 2014).

In terms of spending, China’s public expenditure on education reached 2.2 trillion yuan (about $357 billion) in 2012, accounting for approximately 4 percent of China’s national GDP, and was about evenly split in three ways among Primary (28 percent), Lower and Upper Secondary (31 percent), and Tertiary (31 percent) Education. Of note, the remaining 10 percent of the total education budget is accounted by Pre-primary and Vocational Education spending (Ministry of Education, 2014). In equity terms, China has some of the widest range in regional expenditure per pupil, propelled primarily by the imbalance of regional development. Specifically, wealthier coastal regions spend about 16 times more per pupil than the less development inland regions. To illustrate, in 2010, the national average public expenditure is calculated at 1,097 yuan (about $180) per student per academic year. Among thirty-one provincial administrations, the highest provincial spender budgeted 8,559 yuan (about $1403) per student per year, while the lowest reported was only 538 yuan (about $88) per academic year (Ministry of Education, 2011).

Table 2-1. ***Student Enrollment by ISCED Level, 2010***

ISCED	Level	Enrollment
01	Early Childhood	NA
02	Pre-Primary	29,766,000
1	Primary	99,407,000
2	Lower Secondary	52,759,000
3	Upper Secondary	24,273,000
4	Post-Secondary Non-Tertiary	8,777,000
5	Tertiary-Non University	9,661,000
6	University – Bachelor	12,656,000
7	University – Master	1,279,000
8	University - Doctoral	259,000

Source: Author’s compilation with data from National Bureau of Statistics, 2011

2.12 Teacher Wages in China

Although teacher wage conditions in China present a unique and interesting case, especially from a development perspective, there only exists a very small handful of empirical studies on the topic. In the succeeding paragraphs, I summarize the available related literature. First, average teacher wages have expanded rapidly along with China's economic boom in the recent decades. Between 1990 and 1999, the average primary school teacher wage in China increased from 2029 yuan to 7413 yuan, rising more than three folds within a decade (Chen, 2003). This average wage increase was observed for all levels of education, approximately threefold increase across all levels of instruction. Nevertheless, Chen's (2003) analysis comparing wages of teachers with that of 14 other non-education sectors between years 1990-1999 provided a different picture. In fact, Chen's (2003) calculation suggests that wages for teachers consistently ranked in the bottom quintile in comparison other sectors across all years, while overall salary growth for teachers was only marginally above national inflation rate.

It is important to note that at the sector-average level, implications of slow relative rate of increase in teacher salary compared to other sectors hold key importance. At face value, similar to trends observed by researchers in the U.S. and other developed countries, lag in relative wage growth may lead to decrease in teaching's relative attractiveness as a career option (Hoyle, 2001; Elfers, Plecki, John & Wedel, 2008; Ingersoll & Merrill, 2011). However, sector-wide average wage growth masks potential composition effects of differential quality between age cohorts. For instance, there may exist a quality-quantity tradeoff between newer and older cohorts (see Lakdawalla, 2006; Gilpin and Kaganovich, 2012). If newer cohorts are rewarded disproportionately more for their skills in non-teaching professions, newer cohort entrants into teaching are much less likely to be qualified than previous cohort teacher entrants, thus, the decline in relative wages will upward-bias the actual decline in teacher quality. Notwithstanding, despite these theoretical stipulations, a direct age-cohort comparison of relative teaching versus non-teaching wage gap is not available in the existing literature.

Second, the sheer numeric size and geographic spread of the teaching sector can lead to significant wage inequality, not only in comparison to non-teaching sectors but also within the teaching sector. Geographically imbalanced economic growth is an important driving force behind within-sector wage inequality between coastal and inland provinces. Correspondingly, an inter-provincial study of teacher salaries in 2005 revealed that among all sampled provinces, mean wage was highest in Shanghai at 62,300 yuan per year while the lowest provincial mean wage was less than one fifth of Shanghai's average, found in Henan province (An, 2014; Li, 2007). This large geographic variation in wage growth is in direct contrast with most existing evidence found in developed countries, where the teaching sector is often dominated by across-the-board collective bargaining and characterized by low within-sector wage spread, and often coupled with large purchasing power differences across different Chinese regions. Large wage growth spread, within the teaching sector and across geographic regions, has important implications for this analysis, because self-selection may be driven by both conditions across sectors and across locations.

Third, on top of large regional wage differences, even within the same province, wage inequality appears noticeably large when comparing urban and rural schools. (An, 2014) finds that the average income of rural primary school teachers is approximately 7 to 41 percent lower than the provincial average. Despite being paid conspicuously less, An (2014) finds that rural teachers generally bear greater responsibilities than teachers in metropolitan areas. For instance, in terms of teaching load, 32.2 percent of teachers in cities teach less than 14 classes per week, while only about 14.2 percent of rural teachers report similar amount of teaching load. Rural teachers are also responsible for 1.31 times the number of classes than urban teachers, which are likely due to short-staffing (Xue and Li, 2015). The issue of persistent staff shortages also prompt the examination of current conditions of teacher supply and quality in China.

2.13 Teacher Quality in China

Staffing schools with qualified teachers has traditionally been a huge challenge in many parts of China, as many schools are chronically short-staffed (Sargent & Hannum, 2005). To compound this issue, teacher qualification requirements have been relatively low at the system-level. On the demand-side, many primary schools have traditionally only required a high school diploma, or *shizhuan* certificate, in order to be eligible to become a member of the teaching staff, whereas most lower and upper secondary schools often set the teaching prerequisite to be at least an associate or bachelor's degree (Ingersoll, 2007).

In order to attract new talented teacher recruits, the Ministry of Education initiated free teacher education programs at six of the ministry-affiliated teacher preparation universities in different parts of the country. As requirement, selected teacher candidates need to score above a designated threshold on the National College Entrance Exam in order to enter these free teacher preparation programs, which subsequently require an extended period of commitment in teaching careers in return. In more recent years, most new primary and secondary teachers in China undertake a four year bachelor's education, *benke*, or a two-year associate's diploma education, *zhuanke*, before they begin teaching in public primary or secondary educational institutions.

Policymakers have traditionally used teacher's educational background to screen teachers for prerequisite training, skills, and aptitude. Primary and secondary school teachers are generally required to hold at least a vocational college degree as a base requirement to be eligible to teach, although ones with college degrees or higher are considered favorably in hiring and promotion decisions. Despite relatively low entry qualification requirements, the Ministry of Education, together with provincial and municipal educational commissions, set guidelines, professional standards, and fund teacher education programming initiatives to ensure that a relatively high level of teacher quality.

Once teachers enter the education sector, administrators rely on a system of teacher ranks, or *zhicheng*, and teaching awards to make hiring, assignment, compensation, and promotion decisions (Ministry of Education, 1986). Such observational measures are designed with the goal of providing objective assessments for instructional quality and professional performance that are relatively comparable across different subjects, levels, and geographical regions of instruction. Teacher rank, among primary and secondary school teachers, consists of four levels in descending prestige: senior rank, level one rank, level two rank, level three rank. Teaching awards, an important aspect of consideration for promotion,, are bestowed by different levels of education authorities, ranging from national-level, provincial-level, municipal-level, district-level, and school-level, often through the form of teaching competitions. While increase in rank is and progression of career prestige are obtained sequentially over the entirety of their careers, teacher awards are determined and awarded at relatively shorter time intervals. Commonly, new teachers enter the profession with no predetermined teacher rank, and must earn their placement in entry-level rank.

To be promoted to the next rank, teachers must meet two sets of requirements. First, candidates applying for a certain rank must possess the corresponding level of observable qualifications such as relevant levels of education, years of teaching experience, and length of experience serving as homeroom teacher. Second, potential candidates for rank promotion are assessed based on their classroom and professional performance, including one's mastery of pedagogical skills, instructional tools, and classroom management. Teachers are routinely evaluated within each school on whether or not they should be promoted in rank; such class audit evaluations are conducted by both administrative as well as peer teaching staff (Chu, Loyalka, Chu, Qu, Shi & Li, 2015).

Existing studies have shown that teacher rank is correlated with pecuniary incentives and advancements on salary schedules, which are commonly set forth by local education authorities (Wang & Lewin, 2016). As of 2011, 54 percent of primary school teachers held senior primary rank, while the remaining 46 percent of teachers either did not have a rank or were ranked at level one, two, or three (Ministry of Education, 2014). Importantly, despite teacher rank promotions, teaching award prestige, and salary advancements, studies have shown that many teachers report the lack of career outlets and clear promotion routes as persistent factors influencing their decision to pursue other professional paths (Adams, 2012), which elicits serious complications in teacher recruitment and retention.

Importantly, existing literature assessing teacher quality shifts in China is particularly limited, especially at the micro-analytic level. This may be in part due to the scarcity of data on direct teacher quality or aptitude measures at the individual-level. Most of the existing studies draw on national or regional aggregate numbers provided by the Ministry of Education's yearly statistical yearbooks. Using aggregate data to draw inferences on individual occupational choice is faced with the obvious ecological fallacy problem. Nonetheless, attempts to extend the discussion using individual-level micro data are extremely scarce.

Noting these limitations, surveying the current state of knowledge provide important implications and entry points for further research on this topic. First and foremost, composite measures of teacher quality are correlated with average regional income at the provincial-level. Yang, Wang, Yan, and Shan (2013) provides an attempt to evaluate aggregate-level changes in teacher quality over time. Using data from 31 provinces, Yang et al. (2013) generated a composite index based on five key indicators: student-teacher ratio, classroom-teacher ratio, teachers' education attainment, teachers' rank, and average income. Their study suggests that provinces with higher levels of economic growth are also placed relatively higher on the composite index. Nationally, the average full-time teacher share in primary schools was 85.41 percent, closely in line with the 91 percent cutoff required by the Ministry of Education (Yang, Wang, Yan, & Shan, 2013). Part-time contractual teachers, or *daike laoshi*, consisted of 3.45 percent of the entire teacher population in 2010, down from 3.65 percent in 2009 (Ministry of Education, 2010). For decades, *daike laoshi*, or uncertified and temporary contract teachers, have been recruited to fill rural school vacancies, and often remain in their posts for extended durations due to lack of available replacements.

Second, several studies have explored teacher quality through more direct measures. For instance, Xue and Li (2015) measured teacher quality in terms of level of education. Their study indicated that while improvements have been significant nationally, the gap between urban and rural schools continued to exacerbate. The average educational attainment gap between rural and urban school teachers in 2004 was 1.36 years at the national average level, and in 2013, this same measure increased to 2.04 years (Xue & Li, 2015). Shi and Yan (2006) point out that a supplementary factor in rising teacher quality concerns is the aging of teachers in rural primary schools. Specifically, over half of rural teachers were above 40 years of age, which suggests that the teaching force in rural primary schools may be predominantly comprised of relatively less educated teachers.

In addition, while a majority of the teaching force consisted of women, gender composition varied greatly by location and level of education. According to Ministry of Education (2010) data, the education sector workforce as a whole composed of 58 percent of female. However, national averages mask significant regional variations and differences by level of education. For instance, the male to female teacher ratio in rural secondary schools is 1: 0.8, while the same ratio is 2:1 in primary schools (Shi & Yan, 2006). The potential differences in gender-specific educational attainment may also play an important role in regional variations in teacher quality, and requires further thinking in terms of how to best attract and retain both female and male teacher candidates.

To this end, existing research on the topic of teacher quality is both scant in number and limited in depth. To add, many existing studies on teacher quality in China could be methodologically strengthened and more theoretically based. Few discuss teacher quality in relation to occupational choice theory or look into the broader literature on the economics of education. There currently exists a significant literature gap in understanding how teacher occupational choice, labor market conditions, and teacher quality have interacted over time at the micro-level, especially in a geographically diverse developing country such as China. In light of these realities, a high quality study driven by strong theoretical motivations and taking advantage of the increasing availability of micro-level data is much needed.

2.14 History of Teacher Salary Reforms in China

Teacher salary policies in China have gone through several important transformations in terms of policy institutionalization and programmatic implementation. Until 1955, payment in-kind teacher compensation policies were common in most parts of China, which was then replaced by a national reform to standardize teacher salaries in currency payments (Tian & Yang, 2008). Subsequently, one of China's earliest teacher salary reforms started in 1956, and was characterized by the implementation of a unified wage system that observers conclude as having improved absolute salary terms for teachers (Tian & Yang, 2008). The main motivation behind this reform was to ensure equal pay for equal work, and to enable better budgeting and accounting practices to be put in place nationally for the management of teacher salaries. One of the means in achieving this goal was to gradually reduce the large regional differences in wage distribution. For implementation, the central government issued 11 designated wage zones with particular consideration to variations in living standards and commodity prices based on geography. Policy emphasis was put in key areas of development and poverty-stricken areas, such that wage subsidies were established for different regions in accordance with commodity prices. Importantly, the 1956 teacher salary reform also initiated a long-standing pay scale system that was based on individual ability, qualifications, and rank. For instance, the reform established a rank-based salary system with 10 teacher ranks and 15 administrative grades (Tian & Yang, 2008). In general terms, early reforms is 1956 had laid the pretext for much of the teacher pay scale system that is still in effect in many forms today.

The next wave of institutionalizing reforms occurred during the 1980s, as represented by a series of reforms stemming from the State Council's (1981) *Measures on Adjusting Salaries of Primary and Secondary School Teachers*, in part as policy response to improve teacher salary structures. To this end, the State Council's (1985) *Notice on Government and Public Institution Employee Salary Guidelines* introduced a new salary scale that is more closely tied to job performance; in detail, the new statute stipulated that teacher salaries are to be comprised of four core components: base salary, workload subsidies, tenure-based subsidies, performance-based subsidies. Follow-up reforms through the State Council's (1987) *Notice on Compensation Improvement for Teachers in Basic Education* provided substantive improvements on the existing wage streams for teacher salary determination, and aimed at increasing teacher take-home pay by about 10 percent. This era of reforms established the overarching “base + subsidies” approach for determining teacher salaries, as well as attributing larger proportions of wage scale to workload and job performance.

Subsequent reforms in 1993 and 2006 have been in large parts programmatic fine-tuning and legal mandates based upon policy foundations from previous eras, such that the 1993 teacher salary reform focused on increasing the percentage of workload-based subsidies, while the 2006 reform emphasized on legally guaranteeing comparable pay for teachers. One of the driving forces behind these reform updates was that teacher salary had become incompatible with the country’s overall economic growth (Guo, 1994). In detail, the State Council’s (1993) *Notice on Government and Public Institution Employee Salary Reform Implementation Guidelines* update has further strengthened the link between teacher salary and workload, increasing the percentage of workload-based subsidies to 30 percent of total payments. In addition, the guidelines also established 6 new pay-grade advancements and homeroom teacher subsidy, as well as the central government’s fiscal responsibility to guarantee timely teacher salary payments.

A decade later, the People’s Congress passed the *Compulsory Education Law* in 2006, which instructed all levels of government to ensure favorable wages, living and working standards, and social security benefits for teachers, and acted as a legal mandate that “average teacher salary levels should be no less than that of local public officials” (People’s Congress, 2006, Chapter 4, Section 31). More recent developments in 2009, as stipulated by Ministry of Education’s (2008) *Guidelines on Performance Evaluation of Teachers in Primary and Secondary Schools,* resulted in the implementation of a performance pay policy for teachers in compulsory education schools. In effect, the 2009 reform introduced an incentive mechanism into schools by making approximately 30 percent of wages performance-based, rewarding those who take on more teaching and administrative workload, as well as good teaching performance and engaging in pedagogical research (Wang, Lai, & Lo, 2014). In broad terms, the current literature landscape suggests that the development of teacher salary reforms in China can be broadly categorized into two time periods: an institutionalization era between 1950-1980s, that focused primarily on laying the foundational frameworks in determining teacher compensation; a more programmatic conscious era in providing legal statutes and exploring more effective payment mechanisms, from the 1990s to present.

2.2 Literature Review on Teacher Occupational Choice

Education economists are interested in understanding how rational actors make optimizing decisions based on constraints. Accordingly, in the labor market, optimizing behaviors can help rational actors self-select into various markets and production activities in pursuit of comparative advantage. The formal treatment on self-selection and occupational choice began with the seminar work of Andrew D. Roy (1951). Roy's insights on individuals' decision to optimize choices between 'trout fishing and rabbit hunting' introduced the theoretical foundation for understanding how rational actors make occupational choices. The core content of Roy's (1951) analysis is that a rational worker compares her expected payout, broadly defined in different occupations, and chooses the occupation that maximizes this sum. The worker may choose to assess her expected payout based on several dimensions, such as pecuniary benefits in wages and non-pecuniary benefits, such as occupational status and working conditions (Dolton, Makepeace, & van der Klaauw, 1989). To assume simplicity, most existing analyses have used wage from labor work as a proxy for lifetime utility (Nagler, Piopiunik, & West, 2015), for which the justification derives from the intuition that budget constraints limit individual lifetime choice sets.

2.21 Theoretical Framework

Since the original 1951 article, the basic Roy model has been extensively modified and generalized, and expanded versions include various features such as utility maximization agents (Heckman and Sedlack, 1985), multiple sectors (Dolton, Makepeace, & van der Klaauw, 1989), credit constraints (Banerjee and Newman, 1993), and uncertainty (D'Haultfoeuille and Maurel, 2010). The Roy model has been widely applied by labor economists in various scenarios to understand individual occupational choice mechanisms. For instance, analyses have been conducted on workers' decision to enter market versus non-market sectors (see Heckman, 1974, 1976; Dustmann & van Soest, 1998), unionized versus non-unionized sectors (Lee, 1978), piece-rate versus fixed-pay wage structures (Lazear, 1986). Additionally, the model has also been used to understand workers' choice to emigrate (Borjas, 1987), enter or leave a marriage (McElroy & Horney, 1981), and invest in higher education (Willis & Rosen, 1979).

Broadly speaking, the theoretical foundation of much of the existing occupational literature rests on the cornerstone of human capital theory, such that career decisions are considered as part of an expansive investment project through which investment options between alterative occupations are based on monetary equivalents of costs and benefits that could be accumulated over an individual's working lifetime. In more detail, the analytical logic behind the occupational choice framework literature is similar to that of Rubin's (1974) potential outcomes framework, where individuals maximize expected outcomes in two states of the world: one if *Choice X* is executed, and the alternative if *Choice X* is not executed. To illustrate, consider a world with only two sectors of employment, 1 for teaching jobs and 0 for non-teaching jobs. Mean wages in these two sectors are respectively characterized as μ_0 for non-teaching jobs and μ_1 for teaching jobs. A worker's potential earnings in the non-teaching sector w_0 and in the teaching sector w_1 is given as:

$$w_0 = \mu_0 + \varepsilon_0 \qquad \textbf{(0.1)}$$

$$w_1 = \mu_1 + \varepsilon_1 \qquad \textbf{(0.2)}$$

where ε_0 and ε_1 represent the worker's deviation from the mean sectoral wages μ_0 and μ_1 respectively. Following convention, ε_0 is characterized as a normally distributed random noise, such that $\varepsilon_0 \sim N\ (0, \sigma_1^2)$. In this setup, a worker will choose to work in the teaching sector if expected wage payouts are larger in the teaching sector relative to the non-teaching option, such that $w_1 > w_0$ and conditional on both w_0 and w_1 being above the worker's reservation wage. In this stylized world, all individuals care about when choosing an occupation is their expected earning such that they will chose the occupation that they can expect the highest earnings. Therefore, the condition for a worker to choose a job in the teaching sector can be expressed as the following:

$$(\mu_1 - \mu_0) + (\varepsilon_1 - \varepsilon_0) > 0 \quad \textbf{(0.3)}$$

Therefore, the probability (P) of a randomly chosen worker choosing to join the teaching sector is equal to Pr $[(\varepsilon_1 - \varepsilon_0) > (\mu_1 - \mu_0)]$, and can be algebraically rearranged as the following:

$$P = 1 - \Phi(\frac{\mu_1 - \mu_0}{\sigma(\varepsilon_1 - \varepsilon_0)}) \quad \textbf{(0.4)}$$

where $\Phi(\cdot)$ is the cumulative density function of the standard normal. Equation (0.4) identifies the relationship between probability of choosing to teach and mean wages in each sector, such that the larger the difference between mean wages in the teaching sector μ_1 and non-teaching sector μ_0, the higher the probability P of a worker choosing to become a teacher. Next, setting T=1 for the state of world when a worker chooses to enter the teaching position, $v = (\mu_1 - \mu_0)$, and therefore $z = (\frac{\mu_1 - \mu_0}{\sigma_v})$. In addition, assuming the correlation in earnings between non-teaching and teaching jobs as $\rho = \frac{cov(\sigma_1, \sigma_0)}{\sigma_1 \sigma_0}$, the potential earnings function in the non-teaching sector E(w_0) for a worker who chooses to enter teaching (in the T=1 state of world) can be expressed as the following:

$$E(w_0|T = 1) = \mu_0 - \rho_{0v} \left(\frac{\Phi(z)}{1 - \Phi(z)}\right) \quad \textbf{(0.5)}$$

where $\frac{\Phi(z)}{1 - \Phi(z)}$ is the Inverse Mills Ratio which equals to the conditional expectation of a normal distribution truncated at point z. The potential earnings in the teaching sector E((w_1) for a worker who decides to choose a teaching job (in the T=1 state of world) can be identified as the following:

$$E(w_1|T=1) = \mu_1 + \frac{\sigma_0\sigma_1}{\sigma_v}\left(\frac{\sigma_1}{\sigma_0} - \rho\right)\left(\frac{\Phi(\mathrm{z})}{1-\Phi(\mathrm{z})}\right) \quad \textbf{(0.6)}$$

Based on Equations (0.5) and (0.6), we can better understand the occupational choice mechanisms under Roy model's expected outcome framework. First, we consider a hypothetical case of positive selection into the teaching sector. If a worker who chooses a teaching job is the individual who would have expected to receive above average pay in both the teaching and non-teaching sectors, meaning $E(w_0|T=1) > 0$ and $E(w_1|T=1) > 0$, then the following conditions must hold true:

$$\frac{\sigma_1}{\sigma_0} > 1\,, \rho > \frac{\sigma_0}{\sigma_1} \quad \textbf{(0.7)}$$

These two conditions have important implications in understanding why this 'above average' individual would choose the teaching sector given that he or she could receive above the mean earnings in either sectors. The first condition $\frac{\sigma_1}{\sigma_2} > 1$ indicates that the teaching sector has a larger dispersion of individual earnings, which implies that there is a higher rate of return to human capital. The second condition $\rho > \frac{\sigma_0}{\sigma_1}$ posits that the type of human capital valued by both sectors is highly correlated, or sufficiently overlapped. In this case, an 'above average' individual chooses the teaching sector over the non-teaching sector because the two sectors value the same set of human capital, but the teaching sector offers a higher return to the individual's human capital.

Secondly, for the hypothetical case of negative selection into the teaching sector, that is a worker who chooses teaching is also the individual who would have expected to receive below average pay in both the teaching and non-teaching sectors, $E(w_0|T=1) < 0$ and $E(w_1|T=1) < 0$, then the following conditions must hold true:

$$\frac{\sigma_0}{\sigma_1} > 1\,, \rho > \frac{\sigma_0}{\sigma_1} \tag{0.8}$$

This second case is the exact reverse of the first case. Now, the 'below average' individual chooses the teaching sector with the expectation that he or she would receive below average earnings in either sectors. This is observed because $\frac{\sigma_0}{\sigma_1} > 1$ indicates that the teaching sector has a narrower wage dispersion, implying that by choosing the teaching sector the 'below average' individual benefits from entering teaching because it guarantees a higher wage than otherwise. Again, the second condition $\rho > \frac{\sigma_0}{\sigma_1}$ is the same assumption that the type of human capital valued by both teaching and non-teaching sectors is highly correlated.

Two additional hypothetical cases should also be briefly mentioned here. In the case of $E(w_0|T=1) < 0$ and $E(w_1|T=1) > 0$, meaning if an individual with 'below average' potential earnings in the non-teaching sector and 'above average' potential earnings in the teaching sector chooses a teaching job, then $\rho < \min(\frac{\sigma_1}{\sigma_0}, \frac{\sigma_0}{\sigma_1})$ must satisfy. In other words, the teaching and non-teaching sectors must value sufficiently different types of human capital and that correlation of earnings must be small or negative. Whereas in the case of $E(w_0|T = 1) > 0$ and $E(w_1|T = 1) < 0$, meaning for an individual with 'above average' potential earnings in the non-teaching sector and 'below average' in the teaching sector to choose a teaching job, the satisfying condition requires $\rho > \max(\frac{\sigma_1}{\sigma_0}, \frac{\sigma_0}{\sigma_1})$. This is theoretically unlikely due to violation of the rational choice based on expected outcomes assumption, because the individual would be better off by simply choosing non-teaching sector to receive 'above average' earnings.

When applied to teacher labor markets, the model identifies two key factors that influence the type of individual who pursues a career in teaching:

(1) ratio of wage dispersion between teaching and non-teaching sectors,

(2) correlation between the type of skills valued by teaching and non-teaching sectors

To this end, if worker aptitude and general skills are positively correlated with earnings across different sectors, a rise in the difference in earnings dispersion would result in high ability individuals choosing the sector with higher returns to skills and human capital. Accordingly, given a positive and high correlation between the types of skills valued by teaching and non-teaching sectors, average teacher quality can be substantially influenced by the ratio of dispersion in earnings between the two sectors. For instance, high ability individuals will choose the sector with higher returns to skills, as represented by a relatively wider dispersion of earnings. For instance, this scenario applies appropriately for high ability teachers in STEM fields (Science, Technology, Engineering, and Mathematics).

Assuming their attained human capital in STEM is identically valued across teaching and non-teaching sectors, STEM teachers will choose to work in a non-teaching sector that offers a higher rate of return to their STEM skills, which will have important implications for the observed ability distribution in the teaching sector. Notwithstanding, the implications for understanding the relationship between sectoral wages and teacher quality extend beyond the above applications in STEM fields, especially considering that there are many instances in the education sector where all three of the parameters are interacting at amplified intensity.

2.22 Implications for Teacher Occupational Choice

Economics of education studies have utilized the occupational choice framework to investigate what factors influence individuals' decision to pursue teaching as a career. This line of research was mainly motivated by the frustration over evidence that schools in the U.S. are failing to attract the best and brightest individuals to become teachers (Temin, 2002). Earlier studies carried out by Vance and Schlecty (1982), Weaver (1983), Hanushek and Pace (1995), Ballou and Podgursky (1997) documented that the average teacher's math and verbal skills, as measured by college entrance test scores, have been steadily decreasing. More recent studies continue to confirm this declining teacher quality observation. In fact, Corcoran, Evans, and Schwab (2004), Lakdawalla (2006), Bacolod (2007), and Richey (2014) all present similar evidence on falling relative abilities of teachers in the U.S. These observations of declining average teacher quality emerged with a growing body of evidence that show various measures of teacher quality are instrumental to student outcomes (Hanushek & Rivkin, 2012), and even adulthood outcomes (Chetty, Friedman, & Rockoff, 2014).In most existing occupational choice models, the quality of teacher supply depends on wage and non-wage job characteristics, as well as on how wages and entry requirements in the teacher labor market compare in relation to other sectors in the broader labor market.

To extend on the documented findings of declining teacher quality in the U.S. over the past few decades (see Corcoran, Evans, & Schwab, 2004; Bacolod, 2007; Richey, 2014), an important education research motivation is to understand why teacher quality has experienced such decline and evaluate prominence of potential drivers of such change. Some scholars attribute this decline in quality to women's growing labor participation (Corcoran, Evans, & Schwab, 2004), while others argue that relative wage compression is the explanation (see Hoxby & Leigh, 2004). Scholars also argue that barriers and costs to entry, both direct and indirect, pose barriers for prospective teachers (Angrist & Guryan, 2007). All of these explanations form a basis of understanding for how teachers make occupational decisions and shed light on why these individual occupational behaviors can have sweeping and unintended consequences for the broader education sector. Following the theoretical underpinning of the occupational choice model, economists and education researchers have hypothesized that several labor market conditions can affect the average characteristics and composition the teaching force. Below, I outline three major labor supply explanations: gender desegregation, wage compression, and opportunity wages.

Gender Desegregation in the Labor Market

First, some scholars attribute this declining labor quality to the growing non-teaching employment opportunities for women (Temin, 2002; Corcoran, Evans, & Schwab, 2004;

Bacolod, 2007). Historically, due to low probabilities of entry into gender-segregated sectors, high ability women have low expected earnings in non-teaching sectors, and thus became a captive pool of workers within the teaching sector. In recent decades, progressive gender desegregation in many previously male-dominated sectors led to an increase in women's likelihood of entry, and as a result, an increase in expected non-teaching earnings for women who have a comparative advantage in such sectors. As result, gender desegregation allowed high ability women to seek their comparative advantage and receive better earnings in non-teaching jobs, leading to lower density of high ability teachers.

As explained by Temin (2002), due to historic labor market segregation in hiring practices, high ability women could only seek employment in a limited set of professions such as teaching and nursing; however, with the improvement of gender equality in the past half century, women's occupational choice sets have greatly expanded, and therefore the quality of teachers have become responsive to wages. Yet, in this process, wage levels in the teaching sector has not responded to the rising non-teaching opportunities that have become available to high-ability women. Utilizing five longitudinal surveys spanning between 1957-1992, Corcoran, Evans, and Schwab (2004) document a large decline in teacher quality and observes a lower propensity for women at the top-decile of the individual aptitude distribution to pursue a teaching career, with more than 20 percent in the 1960s falling to just merely 3.7 percent in the 1990s. They find that high-ability women have been increasingly attracted to pursue non-teaching careers such as managers, computer scientists, accountants, and lawyers. This translates into the observed decline of high ability individuals in primary and secondary schools' teaching force.

In the same vein, Bacolod (2007) documents a sharp decline of worker ability in the teaching sector using three different labor force ability measures: standardized test scores, selectivity of undergraduate institution, partner's education and relative wage standing in the population. She finds that the larger the difference in mean wages between teaching and non-teaching sectors, the more likely high ability individuals are to become teachers, simply because of differences in relative wage structures and characteristics. In addition, women and younger age-cohorts are more responsive to wage changes than are men and older age-cohorts. An important contribution of Bacolod (2007) is the attempt to analytically separate supply-side and demand-side factors influencing average teacher quality. She notes that observed occupational choices may be results of a combination of relative supply and demand factors.

Supply side economic analyses have often cited positive compensating differentials as a key explanation for women's choice to become teachers, because the teaching sector requires skills that are complementary with production in the household (Becker, 1985), and allows for less costly labor market exits and re-entries when starting a family (Polachek 1981; Blau, Ferber, & Winkler, 1998). Following these supply-side hypotheses, gender desegregation in occupations shifts women's labor supply inward in previously 'women-dominated' jobs and outward in previously 'non-women-dominated' jobs. This labor supply shift would theoretically result in an increase in relative wages for previously 'women-dominated' sectors such as teaching. Yet, the empirical evidence shows that relative wages in the teaching sector declined, pointing to demand factors as the alternative explanation. Bacolod (2007) shows that relative wages declined more for women than men, indicating a labor demand shift that had provided women with more non-teaching employment opportunities, and is responsible for compositional changes in the teaching force.

Relative Wage Compression for Teachers

Another strand of research argues that relative wage compression in the teaching profession, as opposed to that of non-teaching jobs, has been the main reason why talented individuals leave teaching (Hoxby & Leigh, 2004; Chingos & West, 2012; Leigh, 2012; Correa, Parro, & Reyes, 2015). Wage compression policies within the teaching sector, such as unionization and flat wage structures, translate into a lower return to human capital and skills for teachers. Under such policies, occupational choice theory predicts that high ability individuals would choose to work in non-teaching sectors, which exhibit a higher return to human capital, when considering career options. Accordingly, Hoxby and Leigh (2004), Chingos and West (2012), Leigh (2012), and Correa, Parro, and Reyes (2015) observe negative impacts of relative wage compression in the teaching profession on overall teacher aptitude in the U.S., Australia, and Chile, as high ability individuals choose sectors with higher returns to skills.

In the U.S., Hoxby and Leigh (2004) provide causal estimates of wage compression effects on teacher quality, which approximately equals to a 9 percentage-point increase in the share of individuals with the lowest aptitude rank and a 12 percentage-point decrease in the share of individuals with the highest aptitude rank among teachers. Their results indicate that wage compression explained about 80 percent of the decrease in the representation of high ability individuals in teaching and explained about 25 percent of the increase in the share of low-ability individuals in teaching. Similarly, Chingos and West (2012) study U.S. teachers' opportunity wages and find that women, who leave teaching for non-teaching jobs, experience a greater dispersion in income compared to before leaving their teaching posts. This result implies that better general skills and human capital are valued disproportionately more in non-teaching careers, luring high ability teachers to exit.

In Australia, Leigh (2012) directly models the current wages and the aptitude of potential teacher candidates using administrative data to document teacher labor supply shifts between 1989 and 2003. He exploits the timing and geographic variation of teacher wages, which are set at the state-level by collective bargaining. The empirical results indicate that every 1 percent increase in starting wages of new teachers raises the average aptitude of pre-service teachers by .6 in percentile ranks, with effects strongest for those individuals around the median. In addition, he also finds evidence that relatively wider earnings dispersion in the non-teaching sector, compared to the teaching sector, lowers the aptitude of pre-service teachers, with impact strongest for those at the top of the ability distribution.

In terms of the Chilean context, Correa, Parro, and Reyes (2015) apply a two-sector occupational choice model to empirically examine teacher occupational choice between public and private schools, which is crucially differentiated by centralized earning schedules and merit pay, respectively. Correa, Parro, and Reyes (2015) document positive self-selection for high ability teachers into private schools and negative self-selection for low ability teachers into public schools. The authors interpret their findings as a result of rigid teacher wage regulation in public schools that is heavily dependent on certification and experience, whereas private schools exhibit substantially more flexible rules for hiring, firing and setting salaries.

The Opportunity Costs of Non-teaching Options

Third, along the relative wage compression theory, several scholars hypothesize that the general state of economy creates shocks to non-teaching work opportunities, and can have important implications for the composition of the teaching force (Falch, Johansen, & Strom, 2009; Nagler, Popiunik, & West, 2015; Neugebauer, 2015). This intuition is based on the widely held assumption that the education sector is generally non-cyclical, whereas other private sectors often go through boom and bust cycles. Thus, during times of economic boom, the ratio of earnings spread is typically larger in non-teaching compared to teaching sectors, thus individuals with high ability face a higher opportunity cost to commit to a career in teaching. Whereas, during economic recessions, non-teaching job opportunities dwindle and wages in non-teaching sectors become compressed, and as result, many high ability individuals choose to become teachers.

For instance in Norway, Falch, Johansen, and Strom (2009) utilizes panel data to show that public school teacher shortages are strongly correlated with business cycles, meaning better macroeconomic conditions are associated with a higher degree of teacher shortage in public schools. Nagler, Popiunik, and West (2015) use student-level administrative data from Florida, and find that teachers who enter the profession during an economic recession, are on average .1 standard deviation more effective in raising student math scores and .03 standard deviations more effective in raising student reading scores than teachers who enter during non-recession periods. Under a reasonable assumption that only 10 percent of recession-cohort teachers enter teaching due to the self-selection mechanisms above, Nagler, Popiunik, and West (2015) posit that the expected population effect would translate into approximately 1 standard deviation higher on the teacher value added distribution for recession-cohorts. Neugerbauer (2015) analyzes shifts in labor market conditions and teacher characteristics in Germany between the years 1980-2009. Using a nationally representative sample, he shows that there was no relative decline in teacher wages in Germany over the past three decades. Neugerbauer (2015) explains this observation by linking the relative stable quality of the teaching force with relatively high unemployment risks, and he shows that teacher occupational choice in Germany is very sensitive to labor conditions in the larger economy, specifically unemployment risks.

The Cost Disease and Rising Demand for Education

Apart from supply-side explanations, there are also other factors at play influencing who becomes a teacher. For instance, the education sector has traditionally been thought of as being troubled by an unavoidable ‘cost disease’, that is the rising costs of education far outpace that of inflation in general price levels (Baumol, 1993). The idea behind this concept is that education has been relatively stagnant in terms of productivity improvements. To elaborate, the economy can be divided into two sectors, one being technologically progressive and therefore relatively more productive, and the other being technologically stagnant marked by lower productivity. In the technologically progressive sector, improvements to production technology respond to rising labor costs and substitutes low-cost low-skilled labor for more costly skilled labor, and in turn raises labor productivity.

However, because by nature of production, it is hard to improve productivity in the technologically stagnant sector, worker wages must rise in order to attract and retain workers of desirable quality and aptitude. The inevitable result is that labor cost increase in the technologically progressive sector will be transferred to the stagnant sector where substitution for labor is not easily available. To cope with these circumstances, the stagnant sector can either bid up the price of workers, or face ‘labor-draining’, meaning that skilled labor will be lost to technologically progressive sectors.

To further complicate the issue of rising per unit costs, demand for education has been consistently increasing in most countries, either through economic development or policy expansion to open educational access. One important lesson from economic theory is that the price and quantity of labor is jointly determined by supply and demand factors, which means that demand-side factors can also play an important role. Broadly speaking, scholars posit that skill-biased technological change (SBTC) exacerbates the appreciation of skills and human capital relative to the median worker. Furthermore, sustained growth in skill premium in the general economy creates lasting downward pressure on the average quality of the teaching sector (Gilpin & Kaganovich, 2012). Rising demand for college-educated skilled workers has led to an increase in demand for better education, and under a relatively fixed education budget, education systems can no longer afford to hire high ability individuals as teachers (Lakdawalla, 2006). The main intuition derives from recent imbalanced expansions in education access and education budget, which led to more teachers being hired due to relatively stagnant teacher productivity growth, at a relatively lower unit price for their labor because of relatively fixed educational budgets.

More specifically, Lakdawalla (2006) argues that demand-side quality and quantity tradeoffs play an important role in the decline of teacher quality. Schools are faced with higher public demand for schooling because SBTC increases the prices of skilled labor and more individuals are inclined to pursue education, yet teachers' unit productivity to educate students has remained practically unchanged. For instance, class size has largely remained the same, or decreased, in most countries. Even as the cost of teachers rise, there has been little to no substitution of teacher labor in the education production process. This creates a resource allocation problem for schools, which in turn respond by substituting teacher quality with teacher quantity to cope with this increased demand for education. By utilizing time and geographic variations in the price of skilled labor, Lakdawalla (2006) finds that higher prices for skilled labor appear to be associated with increased education input and declines in relative teacher aptitude measures.

In the same vein, Gilpin and Kaganovich (2012) extend the SBTC analysis by treating public schools as education quality maximizing agents, and explicitly model three factors that may influence quality - quantity tradeoffs: indirect opportunity costs of teachers, unionization and wage compression, and the rise of skill premium. Their general equilibrium model predicts that as mean wages and earnings dispersion increase for college-educated workers, schools are forced to adjust relative teacher salaries and teacher quality standards in response to changes in labor market conditions. As education quality maximizing agents, schools may solve the resource optimization problem by lowering relative quality of teachers and compensate with a higher number of teachers. Gilpin and Kaganovich (2012) show that this prediction is in line with the empirical observations found between 1955 and 2005, that growth of teachers in the U.S. have far outpaced the growth of student enrollment, and while teacher relative wages declined, overall education budget as percent of GDP remained practically stable.

2.3 Implications for the Chinese Context

Several important implications can be summarized from the review of existing literature, especially for understanding how teacher occupational choice, labor market conditions, and teacher quality interact over time in China. First and foremost, the Roy model introduces an economic decision-making framework in understanding how and why teachers choose to become teachers. Researchers in social sciences have often emphasized the impact of norms, beliefs, and structural barriers to employment as explanations for understanding observed choices (see Badgett and Folbre, 2003; Morgan, Walker, Hebl, & King, 2013). In this respect, studies in line with Roy's model provided individuals with more agency by directly measuring teachers' endogenous occupational choice, and consequently led to improvements in designs of teacher labor policy analyses.

Importantly, the model identifies key factors that can generate testable hypotheses regarding who pursues teaching and why. As evident in the basic Roy model, the decision to pursue a teaching career depends on two key parameters: the ratio of dispersion in earnings between teaching and non-teaching sectors ($\frac{\sigma_1}{\sigma_0}$), and the correlation between the type of human capital valued by teaching and non-teaching sectors (ρ). To situate the model more contextually in China, cross-sector improvements in earnings for women can have important effects on the type of individuals who pursues teaching, such that opportunity wages have increased substantially for women. China's rapid economic transformation has led to significant improvements in per capita income (Wen, 2015). Ding, Dong, and Li (2007) show substantial wage increases in female workforce participants throughout 1988-2002. Many scholars attribute a large proportion of this rise in income to the shift from low productivity employment to higher productivity jobs (Brandt and Zhu, 2010). The economic transition from planned to market economy has opened access not only to previously inaccessible private-sector jobs, but also to a new class of high productivity jobs that come with rapid economic development. In this respect, the existing literature on the availability of non-teaching options (see Falch, Johansen, & Strom, 2009; Nagler, Popiunik, & West, 2015; Neugebauer, 2015) is crucial to reconcile with the consequences for teacher quality when previously unavailable career options are made available to teachers and teacher candidates.

Second, given the positive and strong correlation in the type of skills and human capital valued across teaching and non-teaching sectors, average teacher quality is expected to be influenced by the ratio of dispersion in earnings between the two sectors. The combination of a large and rigid public sector with artificially compressed wage structures (Zhu, Prosterman, Ye, Li, Riediner, & Ouyang, 2006), will likely influence individual occupational choice when the economy is undergoing rapidly transitions. Following this theoretical approach, the current discussion (see Hoxby & Leigh, 2004; Chingos & West, 2012; Leigh, 2012; Correa, Parro, & Reyes, 2015) on whether fixed and compressed teacher wage schedules fail to reflect the rising opportunity costs that individuals face is also relevant for understanding consequences for overall teacher quality – in the face of rapid economic development. As a general prediction stemming from occupational choice theory, new workers who belong to the high ability group (broadly defined) would have a lower return on skills in the teaching sector, and thus become less incentivized to enter the teaching sector. At the same time, current teachers who belong to high ability groups, once faced with better non-teaching career options, would have increased incentives to leave teaching for non-teaching jobs, pursuing higher skill premiums.

Third, by empirically exploring parameters related to occupational choice decisions, scholars can answer educationally important policy questions, and identify existing policy gaps that may become problematic in the recruitment and retention of talented teachers. In this regard, various studies including Rockoff (2004) and Rivkin, Hanushek, and Kain (2005) have investigated the impact of teacher quality on student achievement, concluding that by moving up one standard deviation on the teacher quality distribution leads to approximately .1 standard deviation gain in student achievement. It is clear that teachers play a key role in students' learning and the production of human capital. As noted in the occupational choice framework, given that the worker's human capital is valued in both sectors and that correlation of skills is substantially large, high ability individuals will choose to supply their labor in the sector with higher returns, as represented by the larger dispersion of earnings, for those sets of skills. Therefore, short paying teachers may have both immediate consequences in the decline in career attractiveness, but also far-reaching and long-term societal costs, because the decline in average quality of teachers may result in reduced learning and accumulated human capital for students, and therefore curtailed skills preparedness once they enter the workforce.

To this end, numerous studies have shown that foundational skills acquired while in school through good instruction can have long-term impacts on worker productivity, income, and career progression (see Hanushek & Woessmann, 2015; Valerio, Puerta, Tognatta & Monroy-Taborda, 2016). Thus, ensuring the quality of the teaching force has serious policy implications for human capital accumulation both at the micro-individual and macro-country level, and has potentially significant long-term consequences for economic development and societal prospects. By investigating how relative labor market conditions affect teacher occupational choice, policy instruments can be identified to better attract high-quality teachers and become more effective in retaining individuals in the teaching force. In this regard, the current dissertation presents an important theoretical application of occupational choice in teacher labor markets, as well as a policy investigation to aid policymakers in devising teacher recruitment, management, and retention policies that will lead to a bright and well-functioning teaching force that can ultimately improve student learning outcomes.

Chapter III

METHODOLOGY AND DATA

In broad strokes, this dissertation applies quantitative methodology to answer theoretically important and policy relevant questions regarding the relationship between student learning, observable characteristics, teacher quality and teaching wages. More specifically, I plan to first motivate this dissertation by showing the impact of teacher quality on student learning outcomes (Part I), document trends in adjusted wage profiles (Part II), explore how teachers compare to non-teachers on labor quality measures (Part III), and investigate how stagnant wages in the teaching sector have affected the quality of teacher labor supply (Part IV). In particular, I examine specific sets of research questions in the four succeeding sections:

Research Question #1: What is the relationship between observable characteristics of teacher labor quality on student learning outcomes?

- In Part I, using a nationally representative teacher-student linked dataset (China Education Panel Survey, CEPS), I first establish the causal relationship between observable teacher quality characteristics, as illustrated by educational attainment level, on student learning outcomes in Chinese schools. Results from Part I motivate a comparison of relative teacher quality with non-teaching workers using observable human capital traits and signals, such as educational attainment.

Research Question #2: How large is the teaching wage penalty between workers in teaching and non-teaching sectors, after accounting for individual characteristics?

- In Part II, using a nationally representative repeated cross-sectional household survey dataset (China Household Income Project, CHIP), I empirically estimate key parameters in the teacher occupational choice framework, namely mean wage difference and differential returns to skills, and document trends over time. The objective of this exercise is to examine the degree of change in these key two parameters in regards to identifying and assessing observed teacher "wage penalty."

Research Question #3: How has the relative quality of teachers compared to workers in other sectors evolved in the past decades?

- In Part III, using a nationally representative repeated cross-sectional household survey dataset (China Household Income Project, CHIP), I evaluate the extent to which predictions of the occupational choice framework extend to the Chinese context, in terms of observed teacher ability patterns relative to the broader non-teaching workforce. I consider results from this exercise jointly in relation to wage characteristic observations observed in Part II, and discuss the broader implications for the relative labor quality of the teaching force.

Research Question #4: What is the incidence of job turnover for teachers in China? What is the influence of non-teaching opportunity wage on occupational decision?

- In Part IV, I leverage an available nationally representative panel dataset (Rural-Urban Migration in China, RUMiC) on teacher's labor market career decisions and track teachers across year to examine the prevalence of teacher turnover, and identify teacher job switch destinations. In addition, I conduct an exploratory investigating on the relationship between relative non-teaching opportunity wages to teacher's occupational decision, and assess the associated impacts on non-pecuniary outcomes.

3.1 Part I: The Impact of Teacher Quality on Student Learning

Often in the field of economics of education, student learning outcomes are estimated with education production function to illustrate the relationship between student test scores *A* and various types of educational inputs, such as student and family inputs *P*, teacher quality inputs *T*, and school resource inputs *S*.

$$\mathrm{A} = \mathrm{f}\,(P, T, S) \qquad \textbf{(1.0)}$$

In most circumstances, student and family inputs *P* include a vector of individual and family background demographic, socioeconomic, and educational effort factors as well as measures of innate ability and accumulated prior learning. Teacher characteristic and teacher quality inputs *T* often refer to various teacher quality variables, such as teacher's level of educational attainment, certification status, professional development participation, and years of teaching experience. School resource inputs *S* reflect a variety of school-level educational resources that contribute to student learning, such as state of facilities, curriculum content, access to instructional technology, quality of educational facilities, peer composition, and so on.

Accordingly, under the education production function framework, teachers are presumably identified as the most educationally important input factor because it directly influences instructional quality and immediately impacts student learning experience (Hanushek & Rivkin, 2012). Rigorous evaluation studies in the United States, such as those performed by Rockoff (2004) and Rivkin, Hanushek, and Kain (2005) have found that by moving up 1 standard deviation on the teacher quality distribution leads to approximately .1 standard deviation gain in student achievement. Consequently, researchers and policymakers have sought to determine specific teacher characteristic traits that can improve the underlying teacher quality and subsequent student learning outcomes; extensive research on these traits have identified teacher's own educational attainment level (Harris & Sass, 2011), teacher's professional certification status (Clotfelter, Ladd, & Vigdor, 2007), and length of teaching experience (Kane, Staiger, & Rockoff, 2007). However, common measures of observable teacher quality characteristics, such as educational attainment level, experience, and certification, have not always shown consistent results (Levin, 2010).

For these reasons, in Part I, I conceptualize teacher quality as educational productivity, or the marginal product of observed teacher characteristic inputs on student learning outputs, and relate it to teacher's commonly observational traits, such as a teacher's own educational attainment level. In this regard, the research question will seek to understand to what extent observable teacher quality characteristics – teacher educational attainment – matter for student learning outcomes. Particularly, educational attainment is selected among a rich set of teacher observable characteristics for two reasons. First, a teacher's educational attainment level is a broad reflection of academic proficiency, accumulated human capital, and signals of premarket or innate skills, which are all reasonably expected to influence the underlying teacher preparedness and instructional effectiveness. Secondly, unlike education-specific credentials such as teacher licensure, teaching awards, and teacher rank, educational attainment level is a human capital trait that is directly comparable across sectors, which enables a clearer interpretation in the broader labor market.

The objective of conducting this analysis with data from China, is to illustrate the consequences of observable teacher quality inputs, in this case a teacher's educational attainment level, on student learning in a developing country context. More specifically, I utilize causal identification strategy to establish this relationship through measuring the amount of increased learning outcome that can be attributed to having better and more qualified teachers. This analysis motivates the rest of the dissertation by investigating the important implications of observable teacher ability distribution changes, as well as underlying consequences in affecting student learning and broader educational quality.

As common with most educational issues, empirical identification of causal relationships between teacher inputs and learning outputs is challenging. Estimating the impact of observable teacher characteristics on student learning suffers from common selection-bias issues, where there may exist non-random sorting between students and schools, and within schools between students and teachers. In particular, if more qualified teachers are systematically assigned to teach classes enrolled with high-performing students, or if more qualified teachers are compensatorily assigned to teach in low-performing classes, the relationship between teacher qualifications and student learning becomes ambiguous, and could become either upward or downward biased, and results obtained from subsequent analyses cannot be interpreted as causal. To address potentially problematic selection bias issues, I estimate a student fixed-effect education production function with between-subject differencing to link teacher characteristics to student learning using within-student variations across three subjects: Chinese, Mathematics, and English, in teacher quality measures in order to establish the causal relationships between observed teacher quality and student achievement outcomes. In this case, the analytic objective is to identify how student learning outcomes vary for the same student across different subjects in which observable teacher characteristics also vary.

For implementation, I relate within-student, between-subject variations in test scores to between-subject differences in teacher observable characteristics, in order to minimize the confounding influence of student and family unobservable factors. In effect, this student fixed-effect analysis compares test scores of the same students on different subjects that are taught by different teachers. More concretely, for each student, there are as many rows of data as there are subjects tested, where each row represents test scores obtained on each of the tested core subjects: Chinese, Math, and English. Due to each of these subjects being taught by different teachers who have varying degrees of educational attainment, teacher training, qualifications, and awards, I am able to relate this difference in teacher observable characteristics across subjects to the variation in test scores across subjects for each student, and eliminate sources of potential bias to establish causal relationships.

Consequently, I adopt the aforementioned student fixed-effect empirical strategy to address problematic endogeneity problems in three main ways. First, the between-subject variation nature embedded in the strategy eliminates influence of all observable and unobservable student characteristics that do not vary across subjects. Second, benefitting from the two wave nature of the dataset, I include a rich set of subject-varying student-level input information, including baseline test scores and subject-specific student effort. Third, to further address potential omitted variables that differ across subjects, I include a rich vector of subject-varying teacher-level control variables.

The estimation procedure is modified from that of existing literature adopting similar student fixed-effects modelling (see Altinok & Kingdon, 2009; Metzler & Woessmann, 2012), with two important improvements. First, with the abundance of background information collected from the teacher questionnaire, I am able to employ a rich vector of teacher characteristic measures, such as identifying a teacher's general human capital levels, as well as controlling for her pedagogical skills. Second, the two wave structure of the China Education Panel Survey (CEPS) dataset provides a rich set of student-level controls, including prior year test scores by subject and subject-varying student-level effort and motivation variables. With these improvements in mind, for the current case, the key explanatory variable teacher ability (a vector of education level and attained credentials) is included in a standard education production function of the following form:

$$A_{is} = \alpha + \gamma T_s + \mu_i + \varepsilon_{is} \tag{1.1}$$

$$T_s = \{teacher's\ education\ attainment\ level\} \tag{1.2}$$

where A_{is} is student *i*'s test score in subject *s*. T_s is the key variable of interest: level of teacher educational attainment for subject *s*. In particular, I estimate the effect of having at least a 4-year Bachelor's degree, relative to those whose education attainment level is below 4-year Bachelor's. There is no need to include additional student-level controls because I add a student fixed-effect term μ_i, which controls for all student-level observable and unobservable characteristics that do not vary across subjects. Such covariates might include all personal, family, school and broader contextual characteristics at the student-level that do not differ across subjects.

Importantly, it is worth noting that because a "class" in China is defined as a group of students within the same grade, who take the same subject courses together. Therefore, in this analysis, I do not add class fixed-effects or control for any additional "class" characteristics such as class size and peer composition, because all characteristics at this level is regarded subject-invariant. In addition, there may also remain school-level unobservables in the error term, which would be problematic if correlated with student test score or teacher quality variables. However, because student fixed-effects estimation implies regressing within-school, school-level unobservables are arguably subject-invariant and therefore netted out from the error term.

To illustrate in more detail the intuition behind the strategy of using a two subject example, simple differencing between subjects *1* and *2* will yield the following:

$$(A_{i1} - A_{i2}) = \gamma(T_1 - T_2) + (\varepsilon_{i1} - \varepsilon_{i2}) \tag{1.3}$$

where the key coefficient of interest is γ, representing the variation in student achievement that is explained by the difference in teacher educational attainment between subjects *1* and *2*. All student-level subject-invariant observables and unobservables are netted out, whereas the remaining observed and unobserved student and teacher school characteristics that vary by subjects are captured in the error term $(\varepsilon_{i1} - \varepsilon_{i2})$.

A key assumption for causal estimation of γ in this model relies on the fact that the differenced error term $(\varepsilon_{i1} - \varepsilon_{i2})$ is orthogonal to both outcome variables $(A_{i1} - A_{i2})$ and teacher quality vectors $(T_1 - T_2)$. Importantly, this means that omitted student- and teacher- variables that vary by subject could introduce bias for the causal estimation of γ. To illustrate, I discuss each of the three potential scenarios. First, there may exist subject-varying student-level unobservables that are correlated with both $(A_{i1} - A_{i2})$ and $(T_1 - T_2)$. If student-level unobservables, such as effort and motivation, are subject-varying, this would become problematic if these student-level unobservables remain in the error and are correlated with subject-specific teacher characteristics. For instance, if student ability is subject-specific, $(\mu_{i1} - \mu_{i2})$ is not netted out and remains in the error term; and if correlated with teacher quality variables $(T_1 - T_2)$, an omitted variable bias problem could arise. But for that to happen, students must be matched to specific teachers by subject, such that high-performing students in subject s are systematically matched with better teachers for that subject.

In response, I take advantage of the two wave nature of the China Education Panel Survey (CEPS) dataset to include a vector of subject-dependent student-level baseline control variables X_s, which include subject-specific test scores of the previous academic year, as well as rich subject-varying student information on outside-of-class effort, teacher-student interaction, and learning motivation at baseline. For subject-varying outside-of-class student effort, I proxy this with student's attendance in subject-specific private tutoring, whereas I explicitly model for subject-varying teacher-student interaction, and student learning motivation using subject-specific student survey responses. In detail, for each of the three tested subjects, students are asked to answer if they attend outside-of-school private tutoring for each subject, rate their frequency of in-class interaction with each subject teacher, and evaluate the general usefulness of subject content later in life.

$$X_s = \{baseline\ score_{t-1}, tutoring_{t-1},\ interaction_{t-1}, motivation_{t-1}\,\} \quad \textbf{(1.4)}$$

Second, there may exist teacher-level omitted variables that are subject-varying, which are related to outcomes at the student-level. To mitigate this source of bias, I add a vector of C_s, which includes additional teacher-specific baseline covariates that vary across subjects. The vector of C_s is composed of indicators such as teacher's sex, teaching experience, whether the teacher is a homeroom teacher, as well as other observable teacher characteristics: certification status, whether she received preservice training through a normal education program, current teacher rank, and prestige of teaching award received. In addition, to detect the degree of presence in non-random sorting among students and teachers, I also check whether these subject-specific teacher characteristics are correlated with student subject-specific test scores.

$$C_s = \{sex,\ e\square perience,\ homeroom,$$
$$certification, preservice, experience, contract, rank, award\} \quad \textbf{(1.5)}$$

Third, for robustness check, I inspect for possible confounding relationships in respect to ability grouping practices. Specifically, it would be especially concerning if students are assigned to subjects according to their subject test scores, which I control for using subject-specific teacher responses detailing whether class assignment had been based on student test scores on that particular subject. In addition, I also run an independent subsample regression for students whose homeroom teachers reported that ability grouping was nonexistent in class assignment.

In effect, the detailed analytic approach is expanded and presented in the following form:

$$A_{is} = \alpha + \beta X_{s(t-1)} + \gamma T_s + \pi C_s + \mu_i + \varepsilon_{is} \quad \textbf{(1.6)}$$

where A_{is} is student *i*'s achievement score in subject *s*. $X_{s(t-1)}$ is a vector of student-level background characteristics for student *i* that vary across subjects at baseline.

Specifically, for each student i, I control for subject-specific test scores of the previous academic year, baseline enrolment in private tutoring, baseline frequency of student-teacher interactions, and student evaluation on usefulness of the subject content at baseline. T_s refers to the level of educational attainment for the individual responsible for teaching subject s. The model attempts to estimate an unbiased γ as the key coefficient of interest, which reflects the relationship between observable teacher quality characteristics and student learning outcomes. C_s is a vector of additional teacher-specific control covariates that vary across subject: sex, experience, homeroom status, certification status, teacher education attendance, teacher rank, and teaching award received. μ_i is the student fixed-effect, which controls for all student-level observable and unobservable characteristics that do not vary across subjects. Finally, ε_{is} is the remaining error term.

As a final step, in order to assess whether heterogeneity in the relationship between teacher quality and student learning exists in consideration to student background characteristics, I interact teacher quality variables in Equation 1.6 with student baseline characteristics, including student's sex, baseline test scores, minority status, whether she is a "left-behind children" (both parents not living with student), and whether the student reported that her family is experiencing financial hardship. Inclusion of the interaction terms changes the interpretation of the key coefficient γ, which now refers to the impact of teacher's educational attainment on learning outcomes among the advantaged student population. Consequentially, coefficients for the interaction term correspond to the degree to which student learning outcomes of disadvantaged students are differentially affected, relative to advantaged student groups.

3.2 Part II: The Teaching Wage Penalty

In this section, I utilize micro-level individual earnings data to answer the empirical question regarding relative earnings level between teachers and comparable workers in non-teaching sectors. Policymakers across different contexts are generally very interested in recruiting individuals with high aptitudes to enter the teaching profession (see Allegretto, Corcoran, & Mishel, 2008), and consequently, it becomes crucial to examine relative wage characteristics in the teaching sector that teachers face, and ask: are they reasonably attractive for teachers?

In line with the teacher occupational choice framework, returns to skills is one of the key parameters that affects how individuals determine occupational choice, assuming skills demands are sufficiently correlated across fields. To this end, the research objective in Part II is to understand whether there exists a "wage penalty" for individuals who choose to become teachers, compared to workers of similar demographic and background attributes. In this context, a teaching wage penalty can mean that individuals who choose to pursue teaching may face either a lower average sectoral wage or lower returns to their human capital in the teaching sector, holding all else equal.

For implementation, I follow two separate estimation steps. In the first step, I empirically estimate the mean wage difference between teachers and non-teachers using Mincer (1974) earnings function. The results from this first analysis led light on mean sectoral wage differences and carry empirical implications for understanding teacher occupational choice. In the second step, I investigate the degree to which there exists heterogeneous returns to skills in teaching and non-teaching sectors. The rate of returns to skills and human capital in a given sector is a key determinant for occupational choice, as individuals pursue comparative skills advantage in different labor markets. Broadly speaking, by documenting the magnitude and shifts in these parameters over the past decades, I generate predictions of how the quality of teacher supply changes. More concretely, a rise in the difference in mean wages and an increase in the ratio of earnings dispersion would result in high ability individuals choosing between whichever sectors that yield higher returns to skills and/or human capital.

To look more specifically into the empirical application, I adopt standard Mincer (1974) earnings function to estimate regression-adjusted mean wage differences between teachers and non-teaching workers as well as the net effect of skills and human capital accumulation (proxied by Bachelor's degree receipt) on log weekly earnings (see Allegretto, Corcoran, & Mishel, 2008, p.11, for a detailed discussion on the advantages of using weekly earnings, as opposed to using annual, monthly, or hourly wages). To this end, the Mincerian earnings function framework assumes that education, considered a main measure of accumulated human capital, develops general skills valued in the labor market and can explain for the variations found in individual earnings, following the functional form:

$$lnW = f(Edu,\ Exp,\ Exp\ Squared) \qquad \textbf{(2.0)}$$

where the log weekly wages are regressed on education attainment, work experience, and a quadratic function of work experience. In more detail, I adapt this generic form of Mincer function to the estimating of "wage penalty" for teachers, relative to earnings of workers in public and private sectors, while accounting for important background and demographic characteristics at the individual level. The empirical formulation of this relationship is expressed by the following:

$$lnY_i = \beta_0 + \beta_1 Exp_i^2 + \beta_2 PrNT_i + \beta_3 PuNT_i + X_i\beta_4 + \varepsilon_i \qquad \textbf{(2.1)}$$

where Y_i is the natural logarithm of weekly wages, Exp_i^2 is the Mincerian work experience and its quadratic term, $PuNT_i$ and $PrNT_i$ denote dummy variables public sector non-teaching (otherwise =0), and private sector non-teaching (otherwise =0) respectively. In addition, X_i is a vector of individual-level control covariates including educational attainment levels (2-year associate's is the reference category), female (male =0), single (otherwise =0), minority (Han =0), party member (otherwise =0), tenured or permanent contract worker (otherwise =0), age cohort fixed-effects, and worker-type dummy variables. ε_{ij} is the remaining error term. All standard errors are clustered at the province level to account for the data design feature that individuals are nested within sampled provinces.

Importantly, the coefficient β_2 will indicate the regression-adjusted mean wage differences between teachers and private sector non-teaching workers, and the coefficient β_3 will indicate the regression-adjusted mean wage differences between teachers and public sector non-teaching workers. This standard Mincerian model serves as the base model. In subsequent models, I add interaction terms of private sector non-teaching with educational attainment, and public sector non-teaching with educational attainment, which will provide results on whether there are differential returns to education in different sectors. In detail, the expanded specification with interaction terms takes the following form:

$$lnY_i = \beta_0 + \beta_1 Exp_i^2 + \beta_2 PrNT_i + \beta_3 PuNT_i + \beta_5 PrNT_i * Edu_i + \beta_6 PuNT_i * Edu_i + X_i\beta_4 + \varepsilon_i \tag{2.2}$$

where β_2 and β_3 will now indicate the mean wage differences between non-Bachelor's degree holders between teachers and private or public sector non-teaching workers respectively. β_5 and β_6 will refer to the differential returns to having a Bachelor's degree in teaching versus that of private and public sectors. Consequently, the two-step analysis, as illustrated in Equation (2.1) and (2.2), will provide answers to whether there is a "wage penalty" in terms of mean wages and returns to skills for teachers and indication of its magnitude as well as relative shifts over time.

The standard Mincer function is typically estimated using Ordinary Least Squares (OLS) regressions, however, OLS estimates may produce biased estimates (Card, 2001). In addition, as Scott-Clayton and Wen (2017) points out with data in the U.S., controlling for ability and background characteristics are important and matters more for individuals with lower attainment levels. Nonetheless, in this analysis, the goal is to evaluate the relative attractiveness of wages in teaching and non-teaching sectors. Therefore, I do not attempt to argue for causal identification, but will tackle potential endogeneity issues by including additional control variables: year of birth fixed-effects, father's education, and mother's education. Finally, all of the above analysis will be repeated for each wave of available CHIP data, with the objective to illustrate how the regression-adjusted mean wage differences and returns to education change over time.

3.3 Part III: Teacher Quality and Occupational Trends

In Part II, I documented how teaching wage characteristics evolved over time in China, from which I evaluate key parameters central to the occupational choice framework regarding what influences individual's career determination. In this section, I take a step further by exploring labor quality trends in the Chinese teacher labor market. I seek to understand how teachers compare with non-teachers, on a number of labor quality measures. Conceptually, labor quality often refers to the marginal product of skills on some form of labor output. However, such information is often not easily observed, or measured a priori. Therefore, in the following analysis, I conceive labor quality as a vector of observable characteristics that is valued throughout the labor force, in both teaching and non-teaching sectors.

A conventional approach adopted by labor economists, shown in Part II, is to use education and experience-adjusted wages as a measure of labor quality, as schooling and experience are often regarded as proxy for skill level on the job, and wages represent how the market values such sets of skills (Lakdawalla, 2006). However, because different sectors often reward worker skills and ability differently, it becomes problematic in this regard due to simultaneity or reverse causality. Consequently, I elect to focus on a separate class of proxies for labor quality and worker skills – attained education level, upper secondary school selectivity, and national college entrance exam scores – as indicators of labor quality for comparing teaching and non-teaching sectors. These crude measures of human capital are used primarily as proxies of worker skills, and are intended to be interpreted broadly, either as signals of premarket or innate skills, accumulated human capital, and/or academic proficiency for productivity development on the job. While these simple measures only capture some aspects of teacher and/or labor quality, it is difficult to argue that they are either uninformative with respect to the level of human capital and skills attained by the worker or unrelated to teacher or labor quality.

To implement, I use a multinomial probit model to estimate the relationship between measures of labor quality – education level, high school selectivity, national college entrance exam scores – and observed occupational choice in teaching, public non-teaching or private non-teaching careers. To ensure comparability among career outcomes, this part of the analysis is restricted to the professional worker subsample within each wave of CHIP data, in which each employed worker reported to be either an owner, a manger, a professional, or laborer. In addition, while the multinomial probit model is in many ways similar to the multinomial logit model, its error terms are not necessarily required to be independent of each other as in multinomial logit estimation (Greene, 2000). In particular, because multinomial probit does not assume independence of irrelevant alternatives in the outcome choice sets, which may result in computation bias, it is often considered a more accurate alternative to multinomial logit models. In this regard, I adopt a multinomial probit estimation approach in all succeeding models:

$$Pr(T_i = j) = \beta_0 + \beta_1 Q_i + X_i\beta_2 + \varepsilon_i \qquad \textbf{(3.1)}$$

where the outcome of interest T_i is set to equal different observed occupational decisions j for individual i, with being a teacher set as the base comparison category. Respectively, Q_i is defined using different measures of labor quality – education attainment level and high school selectivity – estimated independently in separate models. X_{ij} is a vector of individual-level covariates including female (male =0), single (otherwise =0), minority (Han =0), party member (otherwise =0), and ε_{ij} is the remaining error term. All standard errors are clustered at the provincial level. Coefficients β_1 in the above multinomial probit model is expected to indicate the relationship of different measures of labor quality on individual occupational decision in and outside of teaching careers. For interpretation, β_1 indicates the human capital premium or gap exhibited by teachers on other comparable workers in the private and public sectors. To evaluate the magnitude of the relationship between different measures of labor quality Q_i and individual career decision outcomes T_i, I report marginal effects using Adjusted Predictions at the Mean (APS) for binary and continuous variables separately. For binary explanatory variables, marginal effects indicate the discrete change in predicted probabilities of entry into occupational outcome j as the value of the binary variable changes from 0 to 1. For continuous explanatory variables, the marginal effect reflects the instantaneous rate of change in predicted probabilities that is related to a 1-unit increase.

To further distinguish the differential quality patterns in teacher stock and teacher flow, I report Adjusted Predictions at Representative Values (APRV) using identical multinomial probit regressions, specifically for individuals whose age (*a*) is 30 and for individuals whose age is 50. Marginal effects conditional on age equals 50 years old will approximate the relationship between obtaining a Bachelor's degree and observed occupational choice decisions in the existing stock of the labor force (β_1' in Equation 3.2), while the marginal effect results conditional on age equals 30 years old will illustrate the career decisions of new labor market entrants (β_1'' in Equation 3.3). Finally, the above analysis will be repeated for each wave of CHIP subject to data availability to untangle stock and flow effects in the labor market, and results from this exercise can illustrate how the teacher "ability premium", if there is one, has changed over time.

$$Pr(T_i = j \mid a = 50) = \beta_0 + \beta_1{}'Q_i + X_i\beta_2 + \varepsilon_i \qquad \textbf{(3.2)}$$

$$Pr(T_i = j \mid a = 30) = \beta_0 + \beta_1{}''Q_i + X_i\beta_2 + \varepsilon_i \qquad \textbf{(3.3)}$$

3.4 Part IV:

Teacher Exits, Opportunity Wages, and Non-Pecuniary Outcomes

Over the past decades, China has persistently mobilized its education system to improve teacher quality at the basic education level, and one particular influential strategy has been focused on optimizing the "quality and composition of the teaching force" (State Council, 2017, Section 1). Evidence in the United States and from international contexts has shown that pre-retirement teacher attrition, or teacher turnover, is a key factor in affecting teacher quality, and that job satisfaction including pay and teaching conditions are among the leading causes for departure (Ingersoll, 2001; Aklog, 2005; Hanushek & Rivkin, 2007;

Sutcher, Darling-Hammond, & Carver-Thomas, 2016). Particularly in China, while teacher retention has been a growing concern (Sargent & Hannum, 2005), few empirical studies have examined the influence of job characteristics on teacher turnover rates in this context.

In this section, I seek to investigate the incidence of teacher turnover and exits from teaching posts. Particularly, I evaluate the determinants of teacher's decision to leave teaching posts, and its influence on individual's pecuniary and non-pecuniary returns in the labor market. Existing studies that investigate China's teacher retention and turnover have predominantly relied on prospective approaches and often relied on expressed preferences. Studies often adopt some variation of teacher opinion or attitude surveys, such that current teachers answer questionnaires regarding their intentions to stay or leave their current posts. For instance, Liu and Onwuegbuzie (2012) find that about two-in-five (40.4 percent) teacher respondents in Jilin Province, China report intention to leave teaching had they been given the opportunity, and many teachers cite high level of stress, low salary, inadequate breaks and holidays, heavy workload, and difficult student behaviors as reasons for departure. Using a similar teacher attitude survey of 510 respondents, Liu (2012) also finds a negative correlation between teachers' compensation and their turnover intentions.

However, relying only on attitude surveys and prospective answers on occupational decision can be problematic, because a myriad of factors unrelated to individual's motivation can influence teacher responses, such as the ordering and wording of questions, social desirability bias, and so on (Duckworth & Yeager, 2015). In addition, existing research in developed countries has shown that there are large discrepancies between teacher's actual career decision and recorded survey responses. For instance, teachers often opt for the highest paying job (Steele, Murnane, & Willett, 2010), but when surveyed, tend to turn down the role of pecuniary compensation or the importance of working condition (Liu, Johnson, & Peske, 2004). Such evidence highlights the importance of utilizing revealed career preferences as opposed to only analyzing expressed job preferences.

To this end, this part of the dissertation leverages rich individual-level information available through a linked nationally representative panel dataset, RUMiC 2007 and RUMiC 2008, to track teachers across years and relate compensation levels to teacher's decision to stay or leave teaching. In particular, I connect teacher job exit decisions to the broader occupational choice framework by assessing the relationship between teacher exit decisions and a teacher's observed wage difference from the mean wage of comparably educated workers. The main argument for connecting these two variables derives from the occupational choice framework's prediction that opportunity wages, proxied by alternative non-teaching wages (see Falch, Johansen, & Strom, 2009; Nagler, Popiunik, & West, 2015; Neugebauer, 2015), can influence how teachers make occupational decisions. To be more specific, a teacher's observed wage difference from the mean wage of comparably educated workers measures the earnings spread between teaching and non-teaching jobs among workers with arguably similar levels of human capital, and is conceptualized here as the opportunity cost to commit to a career in teaching. While theoretically relevant, the relationship between opportunity wage and individual occupational choice decisions is not well documented in low- and middle-income countries. Accordingly, this section will attempt to identify the causal impact of teaching-to-non-teaching wage spread on the probability of teachers choosing to leave teaching posts.

However, the causal impact of non-teaching wage premium on teacher's exit decisions cannot be easily estimated in a cross-sectional data because of the fundamental missing data problem for counterfactuals. For instance, researchers can observe only one wage information in one state of the world, either high or low non-teaching premium, for any given individual. Therefore, this analysis anchors on the subsample of tracked teachers available in the linked RUMiC 2007 and 2008 panel dataset to establish reasonable counterfactuals, and leverages within-individual variation to eliminate unobserved time-invariant heterogeneity that may influence job exit decisions. Subsequently, I estimate a standard individual fixed-effect regression in the following form:

$$P\,r(T_{it}) = \gamma \cdot \Delta\widehat{W_{it}} + X_{it}\beta_{\theta} + \mu_i + \varepsilon_{it} \qquad \textbf{(4.1)}$$

where $P\,r(T_{it})$ is the probability of individual *i* identified as a teacher at time *t*, and it is regressed on the key explanatory variable $\Delta\widehat{W_{it}}$, which is computed as the conditional wage difference between teacher i and comparable workers who reside in the same province, with the same level of educational attainment at time *t*. Importantly, γ will represent the relationship between opportunity wages and probability of staying in teaching jobs. X_{it} is a set of time-varying control variables such as logarithm of weekly income, number of work hours per week, and tenure status. μ_i is the individual fixed-effect variable which will effectively eliminate all time-invariant observable and unobservable factors, such as demographic background, educational level, etc. To further account for potential year-sensitive bias introduced through aggregate common shocks, I add year fixed-effect dummies as additional control.

As a final step, I examine how teacher's job-related decisions can impact one's non-pecuniary life outcomes. To implement, I utilize an index of subjective well-being (SWB) available in the RUMiC dataset to proxy for individual's attained utility. Subjective well-being is a holistic psychiatric measure of happiness, life satisfaction, and/or distress (Clark & Oswald, 2002), which was collected on both waves of RUMiC. In detail, the SWB index is constructed using a set of 12 questions, GHQ-12, each indicating 1 as the best scenario and 4 as the worst. Following Fang and Sakellariou (2015), I compute total raw scores on all responses, and subtract it from 48, which results in a composite index ranging between 0 and 36. In detail, I fit an individual fixed-effect model of the following form:

$$U_{it} = \delta \cdot (D_{it} = j) + X_{it}\beta_{\theta} + \mu_i + \varepsilon_{it} \tag{4.2}$$

such that U_i is the derived utility of individual *i* at time *t* and is approximated using the SWB index. D_{it} refers to a choice set of *j* possible career outcomes that individuals can choose from: become a teacher, remain as a teacher, or exit teaching, while δ is a set of coefficients that are associated with each choice. I add X_{it} as a set of time-varying control variables: logarithm of weekly income, number of work hours per week, tenure status, and self-reported health outcomes. Similar to Equation 4.1, μ_i is the individual fixed-effect that will remove all time-invariant observable and unobservables, while adding year fixed-effect dummies will do away with any time-variant common shocks.

3.5 Data

This dissertation leverages the availability of two large and publicly available datasets in China. In Part I of the analysis, I employ student-to-teacher linked data available in the China Education Panel Survey (CEPS) to establish causal links between teacher quality measures and student learning outcomes, whereas in the succeeding Parts II, III, and IV, I utilize the rich earnings data collected from the China Household Income Project (CHIP) to answer questions regarding relative teacher wages and teacher ability trend shifts over time. After a thorough review of the current landscape of publically available micro-datasets in China, these two datasets are chosen among others not only because they offer a large sample size and national representation, but also because their survey questions contain key information on student learning, teacher qualifications, worker wages, among other key variables that are central to answering core research questions which motivated this dissertation. In the following sections, I elaborate in further details regarding main features of these two datasets.

3.51 China Education Panel Survey

Administered by the National Survey Research Center, the China Education Panel Survey (CEPS) is the first nationally representative and longitudinal survey of lower secondary school students in China (National Survey Research Center, 2014). The core objective of the CEPS is to document youth transition as they progress from lower secondary to upper secondary schools and beyond, and collect detailed background information on instructional content and practices, learning environment and facilities, learning outcomes and behaviors, as well as family and socioeconomic conditions. The longitudinal project initially launched in the 2013-2014 academic year and applies a stratified, multi-stage, probability-proportional-to-size (PPS) sampling design, and is devised to be a nationally representative dataset. A total of 22,400 students in 438 classes in 112 middle schools were surveyed at baseline in two age cohorts: seventh and ninth grade students (2 classes per grade, 2 grades per school). The seventh grade cohort is planned to be tracked annually as they move into upper grades in lower secondary schools, while the ninth grade cohort will be followed through their transition into upper secondary education and the labor market.

Baseline Sampling

By design, the CEPS baseline survey follows a school-based data collection procedure, utilizing multi-stage, multi-strata, and proportional-to-size sampling (PPS) methodology. At the first stage, surveyors sample 28 units from an exhaustive list of 2870 county-level administrative units, of which 15 county-level observations are randomly chosen from the national sample, 10 county-level observations are randomly chosen from a list of 120 migrant-dense counties (defined as within-province migrant count exceeding 222 thousand and/or between-province migrant count exceeding 196 thousand), and finally, 3 county-level observations are randomly chosen from the Shanghai metropolitan area (see Table 3-1 for detailed breakdown). At the second stage, local education authorities provide detailed school-level information, including range of grades, school size, percentage of out-of-district enrollment, on all lower secondary schools in their jurisdiction. Based on the county-level school sampling frame and using PPS methods, surveyors randomly identify four lower-secondary schools within each of the sampled county that has at least one seventh grade and at least one ninth grade classroom. In the third stage, surveyors work directly with principals from each sampled school, and within each school, two classrooms from each grade, seventh and ninth, are randomly chosen and subsequently surveyed. If there is less than two classes per grade, all classes enter the sample. In the final step, all students within sampled classrooms, along with all associated parents, homeroom teachers, subject teachers, and principals are all surveyed to form the completed sample.

Table 3-1. ***Number of Observations at Baseline, by CEPS sampling frame***

	National Sample	Shanghai Supplement	Migrant Area Supplement	Total
Grade 7				
Number of Students	5947	821	3511	10279
Number of Teachers	119	24	78	221
Grade 9				
Number of Students	5574	587	3047	9208
Number of Teachers	118	22	77	217
Number of Schools	60	12	40	112
Number of Counties	15	3	10	28

Source: Author’s compilation of CEPS data.

Baseline Data Collection

At each school that is included in the sample, surveyors collaborate with local education authorities to work with school-level leadership personnel to arrange for an appropriate time for data collection. Then, surveyors collect principals', teachers', parents' and students' consent to participate in the study. Next, surveyors directly obtain school-level administrative data on student core subject test scores on Chinese language arts, Mathematics, and English (mid-semester test scores for spring semester, 2013). They also work with teachers and students to arrange for a 45-minute session for each class to complete the cognitive-item test component of the survey. Upon completion of the cognitive test and student questionnaires, all homeroom and subject teachers from the selected classes are surveyed. For subject teachers, only those teaching the three core subjects Chinese language arts, Mathematics, and English are surveyed. If the homeroom teacher teaches one of the three core subjects, her response replaces the subject questionnaire. Finally, parent questionnaires are distributed to students, to be filled by parents at home, and collected the next day by homeroom teachers. Importantly, for each type of questionnaire, the surveyors adopt a detailed verification process to ensure data quality and completeness, with the only exception being on the cognitive test components. The nested nature of the dataset also allows for matching student responses to families', to teachers', and to principals'.

Baseline Variables

The CEPS questionnaire set includes a total of five independently administered surveys, for students, parents, homeroom teachers, subject teachers, and principals. A unique feature of this survey is that it contains rich student-level information including administrative information on core subject test scores, as well as detailed, matched family and teacher background characteristics information. In particular, for each student, information on demographic, cognitive ability, health, family, learning, and extracurricular variables are collected with administrative data on core subject test scores. For each teacher, detailed background information on educational attainment level, years of experience, training, certification, rank, awards, as well as information on instructional effort and behavior, stress level, attitudes, and expectations are available.

Follow-up Data Collection

In the 2014-2015 academic year, CEPS conducted a follow-up survey for all students who all participated in the first wave. While the follow-up survey was conducted at the school-level, the survey team adopted two different strategies in tracking students who were in seventh and ninth grades during baseline survey. For all of the 10,279 students who were in seventh grade at baseline, surveyors considered them potential subjects in the follow-up round. For those who were in the ninth grade cohort during baseline survey, the follow-up survey was mainly to obtain administrative records of test scores and homeroom teacher response regarding student graduation whereabouts.

In the analysis presented in Part I, I focus exclusively on the tracked students in the seventh grade cohort across 112 schools. In the follow-up survey, out of 10,279 students, a total of 9,449 students (91.9 percent) who were in the seventh grade cohort were tracked and surveyed. For the seventh grade cohort, total attrition from the baseline seventh grade cohort sample was 830 students (see Table 3-2 for detailed breakdown by attrition type), of which the three prominent reasons were school transfer (71.1 percent), dropout (14.6 percent), and unknown (6.1 percent).

Table 3-2. ***Number of Follow-up Attrition in CEPS Seventh Grade Cohort, by type***

	Count	Frequency (%)
School Transfer	590	71.08
Dropout	121	14.58
Unknown	51	6.14
Short-term Absence	31	3.73
Long-term Sick Leave	14	1.69
Class Transfer	8	0.96
Long-term Absence	4	0.48
Repeat Grade	3	0.36
Vocational School Transfer	3	0.36
Expelled	2	0.24
Deceased	2	0.24
Sports Team Leave	1	0.12
Total	830	100

Source: National Survey Research Center, 2015.

Similar to the baseline data collection, the follow-up questionnaire set also includes five independently administered surveys, for students, parents, homeroom teachers, subject teachers, and principals. More specifically, I focus on student level test score information on Chinese language arts, Mathematics, and English from the follow-up survey dataset.

These standardized test scores are collected from school-wide mid-semester examinations, for which it is common practice for the entire grade to partake during a common testing period. These mid-semester exams are usually designed collectively by subject teachers in the same grade with clear intentions to test students on curriculum contents, and answer sheets are graded with good rigor and consistency. In some schools, student’s names and class are even hidden from the grader to ensure score validity. Therefore to a degree, core subject mid-semester test scores can be regarded as a consistent measure of student learning outcomes in a given grade.

In practice, I utilize administrative data on student core subject test scores in the follow-up survey found for the seventh grade cohort, and match it to the baseline seventh grade cohort data. I focus on the core subject test scores for three additional reasons. First, these core subjects are crucial for continuing education beyond lower secondary schools in the Chinese context. For instance, the combined weight for these three subjects often exceed three quarters of the total score on standardized admission test to upper secondary education and subsequently access to higher education through the College Entrance Examination. Secondly, these subjects are fundamental to obtaining skills that can facilitate further education and training opportunities. Without the foundational skills obtained through the learning of these core subjects, it will be challenging to take advantage of future skills upgrading opportunities either through continuing education or workplace training. Third, these three subjects are considered core subjects of instruction and takes up more than one half of total instructional time in schools. Therefore, teacher instructional quality and student learning outcomes on these core subjects are arguably key determinants and proxies for overall educational quality.

3.52 China Household Income Survey

The Chinese Household Income Project (CHIP) is a repeated cross-sectional dataset collected by researchers at Beijing Normal University, with support from the National Bureau of Statistics. Beginning in 1989, there has been seven waves of data collection. Among them, five waves use multistage stratified probability method to achieve national representation, which are respectively referred to as CHIP1988, CHIP1995, CHIP2002, CHIP2007, and CHIP2013 (the numbers correspond to the year that survey responses are based on). CHIP1999 included only urban households, while CHIP2008 represented a panel follow-up to CHIP2007, which included an urban household survey, a rural household survey, and a rural-to-urban migrant household survey. Collectively, five waves of CHIP data (with exception of the urban survey in 1999 and the panel follow-up in 2008) anchor on the established National Bureau of Statistics routine household survey sample. Each wave of CHIP data offers a snapshot of labor market conditions at the micro-level, and represents one of the most comprehensive publicly-available repeated cross-sectional data that cover important employment and income information over a time range of 25 years, that is suitable for tracking dynamics of sectoral employment and income characteristics over time.

Parts II, III, and IV of this dissertation leverages the detailed individual-level demographic and earnings information, as well as the large sample size and timing variation available in CHIP data to empirically evaluate patterns in the relationship between relative wages and teacher occupational choice over time. Specifically, I focus exclusively on the urban sample, where wage income is reported for employed individuals, and the labor market conditions are arguably comparable across sectors. In addition, to ensure that the influence of income outliers and data input error, a standard 1 percent winsoring procedure was applied to all wage earnings information, such that the top and bottom 1 percent of wage earnings are replaced with values at the 99 and 1 percentile respectively. As a further step to standardize repeated cross-sectional data for better comparability, I restrict the analytic sample to individuals aged between 16 and 60 at the time when the survey took place.

In Table 3-3 and 3-4, I show the detailed sample size breakdown and geographical distribution by year. In general, the total urban sample size fluctuates approximately between 15,000 and 30,000 across years, while roughly about close to one half of the sample report currently being employed in paid labor arrangements, which include being self-employed and paid helpers in family business operations. Importantly, I identify between 190 – 779 teachers in each wave of the CHIP data. In this regard, because CHIP datasets do not include ISCO or equivalent job-level codes, therefore, identification of teachers are based jointly on sectoral, occupational, and work unit ownership information. Unfortunately, due to data availability, I am not able to distinguish between levels of instruction; however, because teachers who work in primary and secondary education represent the largest population within the teaching force, they are likely oversampled in my identification of teachers. Therefore it is not unreasonable to assume that a substantial number of identified teachers work in primary and secondary settings. Particularly, teachers are identified as professional workers who are employed in the education sector and working in public institutions (*shiye danwei*). In the following section, I provide further information on the data sampling, collection, and variables on each wave of CHIP data in the succeeding text.

Table 3-3. ***CHIP Sample Size, by year***

Year	Full Sample, Urban Individuals	Employed Workers, Urban Analytic Sample	Identified Teachers, Urban Analytic Sample
1988	31827	17073	779
1995	21533	10765	441
2002	21696	9762	505
2007	14695	5465	207
2008	14859	5452	190
2013	19887	7811	429

Source: Author's compilation using Chinese Household Income Project.

Table 3-4. ***CHIP Sample Geographical Coverage, by year***

Year	List of Sampled Provincial-level Regions	Count
1988	Beijing, Liaoning, Jiangsu, Guangdong, Shanxi, Anhui, Henan, Hubei, Yunnan, Gansu	10
1995	Beijing, Liaoning, Jiangsu, Guangdong, Shanxi, Anhui, Henan, Hubei, Sichuan, Yunnan, Gansu	11
2002	Beijing, Liaoning, Jiangsu, Guangdong, Shanxi, Anhui, Henan, Hubei, Sichuan, Chongqing, Yunnan, Gansu	12

2007	Beijing, Shanghai, Liaoning, Jiangsu, Zhejiang, Fujian, Guangdong, Shanxi, Anhui, Henan, Hubei, Hunan, Sichuan, Chongqing, Yunnan, Gansu	16
2008	Beijing, Shanghai, Liaoning, Jiangsu, Zhejiang, Fujian, Guangdong, Shanxi, Anhui, Henan, Hubei, Hunan, Sichuan, Chongqing, Yunnan, Gansu	16
2013	Beijing, Liaoning, Jiangsu, Guangdong, Shanxi, Anhui, Henan, Hubei, Hunan, Sichuan, Chongqing, Yunnan, Gansu, Xinjiang, Shandong	15

Source: Excerpt from Table 2 in Gustafsson, Li, and Sato (2014, p. 29).

CHIP1988

The objective of initiating CHIP1988 was primarily to study income distribution and inequality in China, which involved sampling of provincial-level administrative regions in a stratified multi-stage procedure (Eichen & Zhang, 1993). The urban and rural sampling frames are based on the routine household sample maintained by the National Bureau of Statistics, which included 34,945 urban and 67,186 rural households. Within each household, all members are surveyed. Systematic sampling methods based on income distribution was employed, which derived a cross-sectional dataset that included 31,827 individuals nested within 9,009 urban households, and 51,352 individuals within 10,258 rural households. In-person data collection took place in the spring of 1989, and respondents reported information on sex, age, education, income, employment status, sector of work, party membership, household wealth, along with other demographic background characteristics.

CHIP 1995

Conducted between January and March in 1996, CHIP1995 systematically samples the National Bureau of Statistics' established routine household sample using a stratified multi-stage procedure, which derived an urban sample of 21,533 individuals in 6868 households, and 34,739 individuals in 7,998 rural households. The administered survey questionnaires collected similar background and employment information as in the previous 1988 wave.

CHIP 2002

Conducted in the spring of 2003, CHIP2002 included a rural-to-urban migrant sample in addition to the previously standard urban and rural subsamples. Consistent with previous cycles, the urban subsamples was drawn from the larger National Bureau of Statistics' established routine urban household sample using a multistage stratified probability method to be nationally representative. The sampling procedure yields a dataset with 21,696 individuals in 6,934 households. Survey questionnaire collected similar background and employment information as in previous waves, but with additional information on the selectivity of high schools that individuals attended.

CHIP 2007, 2008 and RUMiC 2007, 2008

To be clear, CHIP 2007 and CHIP 2008 are often referenced in the broader research community as the 2007 and 2008 waves of the longitudinal survey on Rural-Urban Migration in China (RUMiC). Collected in the spring of 2008 and 2009, the two-wave survey was jointly designed and administered by an international consortium of researchers with support from the National Bureau of Statistics. The project was designed to track households so long as they are present in the surveyed cities, which means that the dataset could be evaluated as cross-sectional data independently or linked together as individual panel data. Respectively, RUMiC 2007 and RUMiC 2008 each comprises of three independent survey components: urban household survey, rural household survey, migrant household survey (see Akguc, Giulietti, Zimmermann, 2014). Each of the three survey components includes detailed information on household and individual demographics, employment and income, training and education, health and well-being, among other background dimensions such as social networks, etc.

Of particular interest, the urban sample was derived using National Bureau of Statistics' routine household sample, which involved randomly sampling households in nineteen different cities across sixteen provinces. According to Akguc, Giulietti, and Zimmermann's (2014) reporting, the total number of households surveyed in RUMiC 2007 was 5,005 and included 14,695 individuals, of which 5.8 percent of the baseline sample was lost in the follow-up RUMiC 2008 but added about 1,018 individuals (see Table 3-5). The questionnaires included detailed information on demographics, employment, and socioeconomic variables, such as age, marital status, children, household registration status, as well as migration status and experience.

CHIP 2013

Conducted in July and August of 2014, CHIP2013 collected information on 2013 income and expenditure as well as personal and household background characteristics. Stratified by geographic location, the sampling frame is derived from an established routine household sample maintained by the National Bureau of Statistics which included over 160,000 households in 31 provinces. Systematic sampling derived 19,887 individuals nested within 6,674 households. Similar to CHIP2002, survey questionnaire in this cycle also collected personal background and employment information as in previous waves, as well as additional information on the selectivity of high schools that individuals attended.

Table 3-5. ***Sample and Attrition Information on CHIP2007 (RUMiC2007) and CHIP2008 (RUMiC2008)***

	Number of Households	Number of Individuals	Number of Employed Individuals	Number of Identified Teachers
RUMiC 2007	5005	14695	5465	207
RUMiC 2008	4735	14859	5452	190
Attrition Rate	5.4%	5.8%	-	-
New Individuals	-	1018	-	-

Source: Excerpt from Akguc, Giulietti, and Zimmermann (2014, p.6)

Chapter IV

RESULTS

In this chapter, I sequentially present complete results from each part of the dissertation analysis. However, before proceeding directly into the micro-level analysis results, a brief discussion of macro-level trends in teacher wages is in order to illustrate the broader contextual background for the succeeding micro-level analyses. To situate the discussion more broadly in China's development context, a 30-fold expansion of real GDP since 1978 suggests that labor market conditions have experienced rapid shifts, and the magnitude of change is qualitatively different from most developed economies (Wen, 2015). Drastic shifts within a relatively short window of time may exacerbate the adverse occupational selection effects, especially with the presence of relatively fixed teacher salary schedules and infrequent wage adjustments as compared to other sectors. Therefore, the core objective of this macro-level analysis is to understand how aggregate-level wages in teaching has shifted, as well as identify emerging patterns in the quality composition of teachers using a common measure of human capital: educational attainment. In more detail, I present results from a relative wage accounting exercise at the cross-sector level in Table 4-0-1 as well as taking a deep dive within-education in Figure 4-0-1, and compile worker composition information to show changes in the educational attainment of teachers in Tables 4-0-2 and 4-0-3, as well as examining sources of net teacher intake in Table 4-0-4.

Firstly, in Table 4-0-1, following Lakdawalla (2006) and using most recently available disaggregated sectoral wage data, I deflate teacher wages using national average worker wage for a given year, and for easy interpretation, log point changes are transformed as percent changes. In broad strokes, Table 4-0-1 shows that observed wage growth for teachers, relative to the average national worker between 1999 and 2009, has substantially regressed, at -44.1 percent for primary school teachers and -46.7 percent for secondary school teachers respectively. This wage accounting exercise indicates that relative wages for teachers have been growing at around half the growth rate of wages for the national average worker between 1999 and 2009.

As a point of reference, Lakdawalla (2006) demonstrates that most high-income countries witnessed relative teacher wage growth rates in the range of -28.8 percent for Sweden and 7.25 percent for Japan over three decades, between 1965 and 1994. In scilicet, the magnitude of relative teacher wage lag in China is much greater than that of developed economies, and occurred at a much quicker rate, approximately less than a third of the timeframe. Despite these consequential changes, few studies quantitatively discuss the impact of teacher wage characteristics on teacher quality shifts in China, or provide any rigorous research that relate observed teacher labor supply patterns to the existing occupational choice literature. Thus, a formal analysis of teacher occupational choice in the Chinese context is justified, and can provide important insights not only for exploring policy instruments that recruit and retain more capable and educationally productive teachers, but such empirical work is also crucial for understanding individuals' labor supply decisions in rapidly developing economies.

Table 4-0-1. ***Teacher Log Wage Growth 1999 -2009, national mean deflated***

	Primary School Teacher Wage, percent change	Secondary School Teacher Wage, percent change
National Average	-44.12	-46.73
Anhui	-40.14	-43.43
Beijing	-51.52	-53.84
Chongqing	-45.31	-43.18
Fujian	-48.37	-46.08
Gansu	-48.17	-51.59
Guangdong	-54.79	-56.40
Guangxi	-40.44	-45.56
Guizhou	-38.76	-44.24
Hainan	-44.91	-50.40
Hebei	-36.98	-40.20
Heilongjiang	-49.46	-49.31
Henan	-31.72	-37.64
Hubei	-47.19	-51.34
Hunan	-44.33	-46.82
Inner Mongolia	-42.79	-39.05
Jiangsu	-44.28	-44.06
Jiangxi	-42.60	-54.44
Jilin	-40.40	-44.57
Liaoning	-31.00	-39.19
Ningxia	-46.12	-46.41
Qinghai	-38.27	-45.12
Shaanxi	-35.65	-37.04
Shandong	-36.47	-41.54
Shanghai	-38.15	-42.03
Shanxi	-42.04	-46.44
Sichuan	-50.84	-51.02

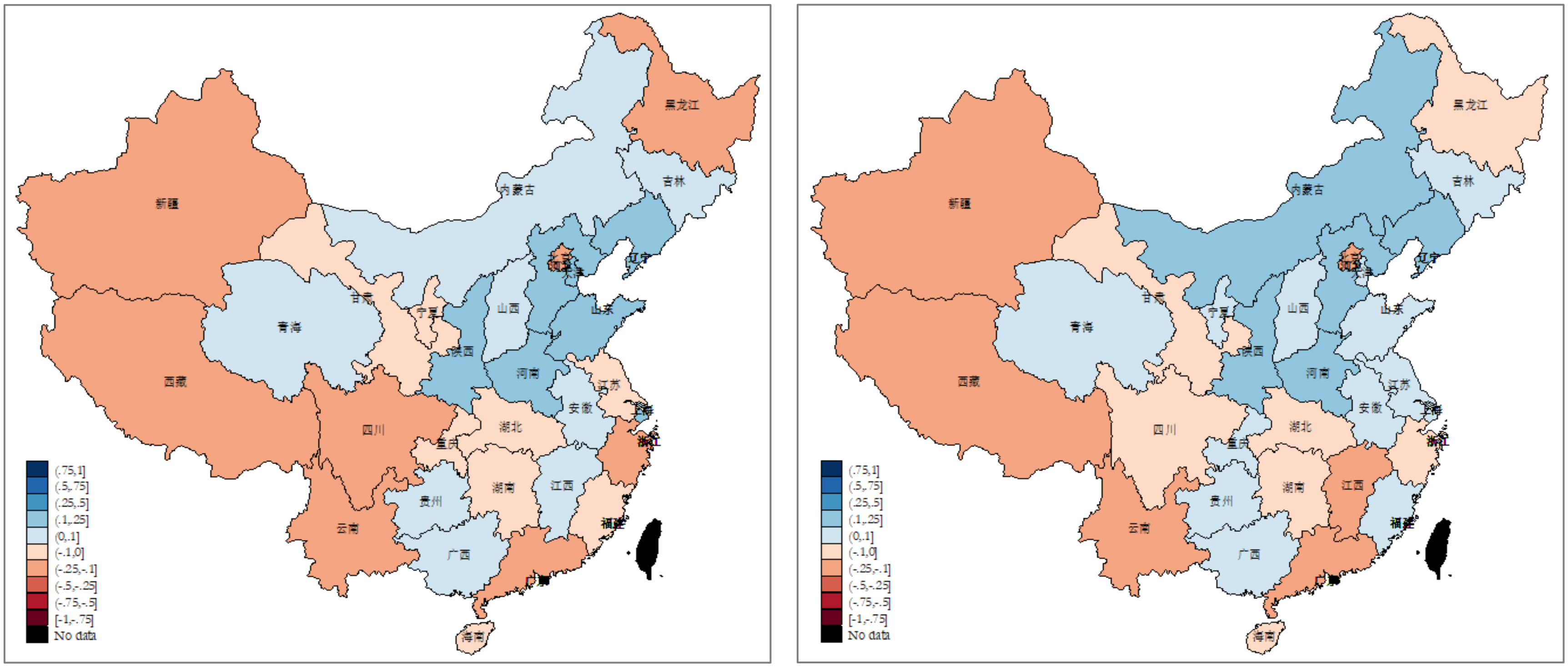
Tianjin	-35.17	-41.81
Tibet	-50.03	-55.34
Xinjiang	-53.72	-55.34
Yunnan	-54.97	-56.47
Zhejiang	-49.53	-47.89

Source: Own calculations, based on National Labor Statistics Yearbook, 1999, 2009. Note: Data for special administrative regions of Hong Kong, Macau, and Taiwan is not available.

To add, the sheer numeric size and geographic spread of the teaching sector led to significant wage inequality not only in comparison to the non-teaching sector, but also within the teaching sector. In Figure 4-0-1, I visualize the large differences in wage growth at the provincial level for both primary and secondary school teachers. For instance, in Yunnan (southwest on the map), the average primary teacher wage growth is 21.6 percent less than the national average teacher between 1999 and 2009, while in Shanghai, the wage growth is 10 percent more. This large geographic variation in wage growth is in direct contrast with most existing evidence found in developed countries, where the teaching sector is often dominated by common collective bargaining and characterized by low within-sector wage spread, which may be further exacerbated by potentially large purchasing power differences across different regions. To this end, large wage growth differences and wage spread, within the teaching sector and across geographic regions, has important implications for the succeeding analysis, because self-selection may be driven by both conditions across sectors and across locations.

Figure 4-0-1. ***Teacher Log Wage Changes 1999-2009, sector mean deflated***

Panel A | Primary Teachers **Panel B| Secondary Teachers**



Source: Own calculations, based on National Labor Statistics Yearbook, 1999 and 2009.

Note: Log of teacher wage have been deflated using national teacher mean wage for each given year. Darker shade of red represents steeper relative decline, darker shade of blue represents steeper relative increase.

Secondly, I track compositional shifts in educational attainment of teachers relative to workers in the broader labor market. Using both the earliest as well as most recently available data from National Labor Statistics Yearbook (2003, 2017), I calculate changes in the percentage of workers in each sector with a given level of educational attainment and deflate it using the national mean growth rate. In general, teachers are becoming more educated, and the rate of increase is much quicker in the education sector. Detailed results are presented in Table 4-0-2, and each cell is to be interpreted as the percent change in educational attainment level of workers in that sector relative to the growth at the national mean. For instance, between 2003 and 2017, the percent of teachers with at least a Bachelor's degree grew as much as 4 times relative to the national average growth in percent of workers with at least Bachelor's degrees (6.8 percent, while teachers with an Associate's degree decreased at about 2.8 times the national average growth in percent of workers with Associate's degrees (5.3 percent).

Thirdly, to examine more deeply within the education sector, in Table 4-0-3, I decompose educational attainment for teachers by different levels of instruction: primary, lower secondary, and upper secondary. Particularly, I find that educational attainment for teachers at different levels of instruction have systematically increased. For primary schools, the percentage of teachers with at least Bachelor's degrees increased from less than 1 percent in 1999 to close to 20 percent in 2009, and reached more than half (50.4 percent) of all primary school teachers in 2016. At the lower secondary level, the growth in teachers with at least a Bachelor's degree was also substantial, expanding 5 times from 12.4 percent in 1999 to 59.4 percent in 2009; by 2016, approximately 4-out-of-5 lower secondary school teachers have at least a Bachelor's degree. At the upper secondary level, similar trends are observed; 65.9 percent with Bachelor's degree in 1999 have increased to over 90 percent in 2009 and close to 100 percent by 2016. Overall, observed patterns across instructional levels indicate that educational attainment levels of teachers at all instructional levels have increased sharply, with majorities of teachers holding at least an associate's or bachelor's degree by 2016.

However, in more recent years, the relative educational attainment advantage of teachers relative to workers in other sectors is quickly dissipating. Importantly, between years 2003 and 2017, the education sector saw the highest increase in workers with at least a Bachelor's degree, narrowly placing ahead of "Finance and Banking" (3.93 times the national mean). Other sectors that saw similar sizable increases are "Scientific Research and Development," "Public Health and Social Welfare," "Information Technology," "Government and Public Administration," and "Leasing and Business Services," which all exceeded twice the national average growth in the percent of workers with at least Bachelor's degrees. On the other hand, results in columns four, five and six on Table 4-0-2, indicate that the growth of teachers with at least Bachelor's degrees has been dwarfed by several sectors in recent years. To illustrate, the percent of workers with at least a Bachelor's degree in the "Finance and Banking" sector grew at 2.55 times the national average, followed by "Information Technology" (2.47 times) and "Public Health and Social Welfare" (2.46 times), while the "Education" sector grew at 2.2 times the national average rate between 2009 and 2017. In addition, share of workers with 2-year Associate's degree also sharply decreased in the education sector, more than any other sector, for the same years. Overall, results show that while the number of workers with at least a Bachelor's degree has been growing in the education sector as well as most other sectors, in more recent years, sectors such as "Finance and Banking," "Information Technology," and "Public Health and Social Welfare" have been quickly catching up and recruiting workers with Bachelor's degrees at a comparatively faster pace. That is to say, the flow of higher quality workers to non-education sectors is gaining considerable momentum.

Fourthly, because teacher composition has positively shifted since 1999, I evaluate to what extent this phenomenon may have been driven by new entrant teachers or teacher exits. Due to the Ministry of Education began reporting source of new teachers only after 2004, in Table 4-0-4, I report net intake information for teachers by source, level of instruction for 2004, 2009, 2013, and 2016. For interpretation purposes, a positive number in each cell means there are more teachers entering than there are leaving, conditional to prior year's total teacher employment size, whereas the opposite is true for negative numbers. While the Net Total results are important, it could be biased by many factors such as policy shocks as well as demographic transitions; therefore, I focus on the net intake source categories. For primary schools, there were no consistent patterns, but there is seemingly more teachers retiring than there were new entrants in 2004 and 2009. Additionally, substantial net transfers into teaching and within-school adjustments into teaching are also observed for 2009 and 2016. In lower secondary schools, there is a consistent pattern that net intake in new teacher entrants is a main source of compositional change, in additional to a significant amount of net transfers and within-education adjustments out of teaching. At the upper secondary level, net intake in new teachers is a substantial source in the replenishment process, while there also exists a mixed pattern of volume in both directions: net transfers from outside of education and net within-education adjustments out of teaching posts.

To briefly summarize the macro-level analytic findings, I outline the main results. On the one hand, while average growth in teaching wages are relatively experiencing large declines in comparison to the cross-sector national mean wage, relative labor quality in the education sector, as approximated by educational attainment levels, has until recently shown greater growth compared to most other sectors. Nonetheless, higher growth sectors such as “Finance and Baking” have begun to attract highly educated workers than the education sector in more recent years. On the other hand, growth in educational attainment among teachers at different instructional levels has been large and relatively even across instructional levels. Moreover, in accounting for source of teacher intake, new teacher entrants seem to be the most consistent source, while there is considerable net transfer out of teaching to other sectors at the lower secondary level. Finally, while the macro-level analysis are limited by the availability and type of data, its findings are instructive for understanding the broader context of teacher occupational choice in China, with respect to alternative career options. This dissertation proceeds to present a more detailed investigation in the succeeding subsections with respect to teacher’s occupational decisions.

Table 4-0-2. ***Workers' Educational Attainment Growth, 2003-2017, national mean deflated***

	2003-2017 Growth, deflated by national mean			2009-2017 Growth, deflated by national mean		
	Bachelor's & Above	Associate's Degree	High School & Below	Bachelor's & Above	Associate's Degree	High School & Below
National Average	100	100	100	100	100	100
Education	400.4	-281.8	101.1	219.9	-195.4	25.8
Finance and Banking	393.3	-98.3	177.6	255.7	-67.6	104.3
Scientific Research and Development	341.7	-38.0	174.1	218.8	12.1	122.1
Public Health and Social Welfare	295.2	90.3	203.0	246.1	-63.3	101.6
Information Technology	284.8	82.7	193.9	247.6	74.9	166.6
Government and Public Administration	280.0	-167.6	83.5	204.8	-109.2	58.1
Leasing and Business Services	254.4	231.1	241.3	72.5	6.5	41.6
Electricity, Gas and Water	197.2	152.2	176.0	124.4	87.1	107.2
Culture, Sports and Entertainment	166.7	-110.4	45.1	141.8	38.5	93.8
Mining and Quarrying	114.4	176.2	140.3	115.0	156.8	134.7
Wholesale and Retail Trade	72.5	152.0	106.4	56.8	102.0	77.9
Environment and Public Utility	72.3	-20.2	32.4	54.8	37.0	46.5
Real Estate	70.4	-41.2	21.4	83.6	45.6	65.1

Manufacturing	66.2	94.1	78.6	61.7	80.7	70.6
Transportation, Post, and Telecommunications	61.7	80.5	69.4	53.7	65.7	59.3
Personal and Other Services	46.6	71.5	56.2	40.4	51.1	45.3
Hospitality and Catering Services	26.6	61.7	40.8	20.7	39.4	29.5
Construction	25.8	25.9	25.6	23.6	18.8	21.5
Agriculture	3.0	6.9	3.8	2.6	5.8	4.1

Source: National Labor Statistics Yearbook, 2003, 2009 and 2017. Note: Relative changes in percent of workers with a given educational attainment level has been deflated using the national mean for that level in that given year. The national mean growth rate in percent of workers with a given educational attainment level between 2003-2017 for Bachelor's and above is 6.809 percent, for Associate's is 5.296 percent, and for High school and below is -12.205 percent; the national mean growth rate between 2009-2017 for Bachelor's and above is 6.050 percent, for Associate's is 5.310 percent, and for High school and below is -11.360 percent.

Table 4-0-3. ***Percent Teachers by Educational Attainment, by level and year***

	Year	Bachelor's and Above	Associate's	Upper Secondary and Below	Total
Primary Teachers	1999	0.7	15.5	83.7	100
	2004	4.6	44.2	51.2	100
	2009	19.8	55.0	25.2	100
	2013	37.2	50.1	12.7	100
	2016	50.4	43.2	6.3	100
Lower Secondary Teachers	1999	12.4	73.2	14.4	100
	2004	29.1	64.7	6.2	100
	2009	59.4	38.8	1.7	100
	2013	74.9	24.4	0.7	100
	2016	82.5	17.3	0.2	100
Upper Secondary Teachers	1999	65.9	32.5	1.7	100
	2004	79.6	20.0	0.4	100
	2009	93.6	6.3	0.1	100
	2013	96.8	3.1	0.1	100
	2016	97.9	2.0	0.0	100

Source: National Education Statistical Yearbook, 1999, 2004, 2009, 2013, 2016.

Table 4-0-4. ***Share of New Teachers as Percent of Prior Year Total Teacher Employment, by source, teaching-level, and year***

	Primary Teachers				Lower Secondary Teachers				Upper Secondary Teachers			
	2004	2009	2013	2016	2004	2009	2013	2016	2004	2009	2013	2016
Net Total	-1.29	0.20	-0.01	1.83	0.17	1.27	-0.67	0.35	11.25	1.20	2.13	2.25
Net New Recruit In	-0.41	-0.12	0.33	1.10	1.84	1.53	0.69	1.29	7.12	0.57	2.57	2.21
Net Transfer In	-0.17	0.41	-0.05	0.84	-0.56	-0.43	-1.22	-0.49	2.86	0.14	-0.11	0.33
Net Within-Education Adjustment In	-0.16	0.11	-0.18	0.02	-0.71	0.32	-0.40	-0.19	1.40	-0.82	-0.07	-0.01
Net Other In	-0.55	-0.19	-0.11	-0.14	-0.40	-0.15	-0.17	-0.26	-0.14	-0.34	-0.26	-0.27

Source: National Education Statistical Yearbook, 2004, 2009, 2013, 2016. Note: The average total teacher employment numbers for 2004, 2009, 2013, and 2016 are 5648745, 3480049, 1459080 for primary, lower secondary, upper secondary respectively. Net Recruit In is defined as the difference between number of new teacher entrants and number of retiring teachers. Net transfers refers to the difference between the number of teachers who entered teaching from another sector and the number of those who have left teaching for another sector. Net within-education adjustments is categorized as the difference in number of non-teaching school staff (e.g. administration or support staff) that switched to a teaching post and those who switched from a teaching post to a non-teaching position. Net others includes all undefined reasons.

4.1 Results for Part I:

The Impact of Teacher Quality on Student Learning

An educationally-important and policy-relevant objective of this section is to establish whether commonly observed teacher background characteristics, such as educational attainment level, are causally linked to affect student learning outcomes. Existing research has shown that this relationship can be empirically ambiguous. Therefore, to rigorously answer this research question, I employ a student fixed-effect strategy to relate differences in teacher characteristics across subjects to variations on student test scores. Effectively, this methodology helps eliminate all student-level observable and unobservable subject-invariant factors, and in effect compares how student test scores vary for the same student across different subjects in which teacher characteristics also vary, after controlling for important student- and teacher-level variables that are different across subjects. In the succeeding sections, I present the detailed results.

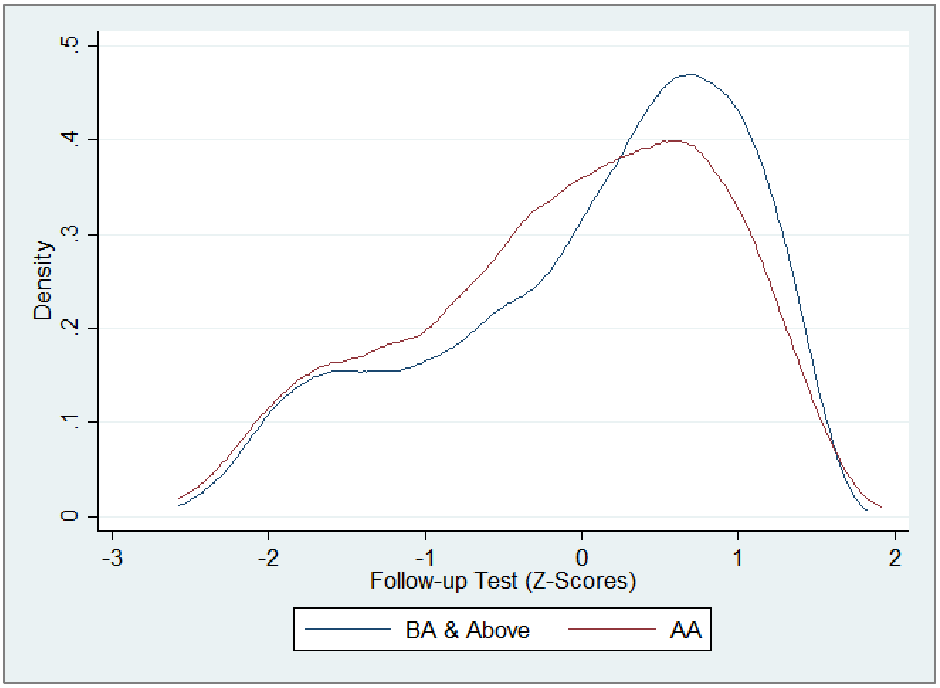
For each of the test score outcomes, administrative data is directly obtained at the school-level, and collected once at baseline survey and another during the follow-up wave. In Table 4-1-1, I present a correlation matrix and descriptive statistics of all student-learning outcomes used in the following analysis. Importantly, the correlation of within-wave, between-subject and between-wave, within-subject are at least moderate; some are strongly correlated. For instance, the correlation coefficient for Chinese, Math, and English test scores at baseline range between 0.64-0.72 (p-values <.05) and 0.68-0.73 (p-values <.05) at follow-up, indicating strong correlations and good internal reliability. In addition, the correlations between baseline and follow-up test scores for each of the three respective tests are 0.71-0.74 (p-values <.05), which also demonstrate strong test-retest reliability across waves. Due to each school administering similar but not identical tests, each test score outcome is first transformed into percentages by taking the quotient of the raw and total score, then independently standardized at the grade- and subject-level within schools; therefore the unit of interpretation changes to standard deviations within -grade-, -subject, and -school. In Figure 4-1-1, I plot the distribution of students' standardized follow-up test scores by subject teacher's educational attainment level.

Table 4-1-1. ***Correlation Matrix and Descriptive Statistics between Test Score Types***

Test Score Variables		1	2	3	4	5	6
1	Baseline Chinese	1					
2	Baseline Math	0.64*	1				
3	Baseline English	0.72*	0.70*	1			
4	Follow-up Chinese	0.73*	0.56*	0.63*	1		
5	Follow-up Math	0.58*	0.71*	0.61*	0.69*	1	
6	Follow-up English	0.58*	0.62*	0.74*	0.68*	0.73*	1
N		5032	5032	5032	5032	5032	5032
Mean		75.64	73.73	79.86	78.59	71.53	67.57
SD		18.22	28.07	26.62	22.06	32.76	30.19
Max		136	150	150	142.5	150	150
Min		1	3	3	0	0	0

Note: Rows 1-6 show Pearson's R correlation coefficients. * denotes p-value <.05

Figure 4-1-1. ***Distribution of student test scores by teacher's educational attainment***



Note: Author's compilation according to CEPS data. This chart plots student test scores for all three tested subjects: Chinese, Math, English by subject teacher's educational attainment level. Kernel density is computed using Epanechnikov method, bandwidth for "BA & above" is 0.1333, bandwidth for "AA" is 0.1852.

In Table 4-1-2, detailed information on descriptive statistics is introduced, for both student level variables (see Panel A) and teacher-level variables (see Panel B). In the seventh grade subsample drawn from the nationally representative CEPS data, there are a total of 5,032 students and 357 teachers. In Panel A, I discuss subject-varying student-level variables relevant to the current analysis. To begin, between 10 to 16 percent of students in the sample report that they attended private tutoring last week for the three core subjects: Chinese, Math, and English. Close to 90 percent of students indicated that they find each of the three subjects valuable for their later life developments. In terms of classroom learning experience, between 63 to 67 percent of all students reported that they felt their subject teachers were frequently interacting with them during class instruction.

In Panel B of Table 4-1-2, I report descriptive statistics information on subject-varying teacher characteristics. First, approximately 73 percent of all teachers are female, and close to a third (29 percent) of them serve as homeroom teachers, whose teaching responsibilities extend beyond course instruction but also include class management duties such as student counseling, parent coordination, etc. Second, in terms of teacher preparation, certification and contract, most teachers report having attended a pre-service teacher education "normal" program (93 percent), and 97 percent of all teachers received official teaching certifications issued by the government authorities. In China, pre-service teacher education (normal) program is defined as attending an educational institution or program that specializes in training pre-service teachers; these institutions are commonly accredited by the Ministry of Education based on a broad base of quality that range from facilities to curriculum. For employment status, only about two thirds (64 percent) of all teachers report to hold permanent appointments or *bianzhi* in their respective schools, while others (36 percent) self-identify as being employed on temporary contract arrangements at their current school.

Third, I report teacher's baseline pedagogical skills levels with information on their teacher rank and teaching awards. Teacher rank, or *zhicheng*, consists of four levels in descending prestige: senior rank, level one rank, level two rank, level three rank. To promote in teaching rank, teachers often undergo rigorous review of the credentials, training, and performance. Teaching awards, on the other hand, are bestowed by different levels of education authorities, ranging from national-level, provincial-level, municipal-level, district-level, and school-level, and are commonly awarded through formal teaching competitions. In the current sample, 84 percent of all teachers self-identify as Level 2 rank or above, while about one third (35 percent) received at least a Municipal-level or superior teaching award. Fourth, in terms of workload, the sample mean was 44.59 hours (SD=12.89) for the past week, with a wide range (12-100). In addition, the sample mean for teaching experience is 14.67 years (SD=8.67), with a range including new teachers (0 years) and veteran teachers (39 years).

Fifth, in order to assess the extent to which student ability grouping practices may influence or confound observed impacts, I also report teacher responses on whether classes are assigned based on a combined total score, or subject-specific scores. Importantly, if ability grouping is prevalent such that non-random sorting occurs between students and teachers, selection bias may confound the results. At the teacher-level, 28 percent of teachers indicate that students are assigned to classrooms using a combined test score, while 12 percent of teachers report individual test scores are used to assign students to classrooms. In the succeeding analysis, the second type of class assignment based on subject scores could be particularly more worrying and problematic, because it introduces unobserved subject-varying unobservables that may be correlated with both teacher characteristics and student test score outcomes. To address these potential issues, I explicitly model these relationships in the sensitivity and robustness checks. Last but not least, for the key variable of interest, teacher's educational attainment level, all but 2 teachers, who completed education at the vocational secondary level, report having at least an associate's degree (2-year *zhuanke*), while approximately 83 percent obtained at least a bachelor's degree (4-

year *benke*). This will be the key variable of interest in the succeeding analysis.

In Table 4-1-3, I evaluate the degree to which teacher observable characteristics differ across subject. As mentioned previously in the methods section, if there are systematic differences in teacher observables or unobservables, which are related to student outcomes, estimated results may be biased. I empirically check for this possibility in the dataset. In effect, I compare to what extent teacher characteristics are different across subjects, where each row in Table 4-1-3 represents an independent regression of various teacher-level variables on subject, with the reference subject group being Chinese. The results indicate that relative to Chinese subject teachers, Math teachers are less likely to be female and hold a teacher rank above Level 2, whereas English teachers are more likely to be female, less likely to have attended a pre-service normal education program, and less likely to report class assignment was based on subject score. To be clear, in Table 4-1-3, I do not find systematic differences on teacher observable baseline characteristics by subject.

Table 4-1-2. ***Descriptive Statistics of CEPS Seventh Grade Cohort Students and Teachers***

	Definition and Metrics	N	Mean	SD	Max	Min
Panel A: Student-Level Variables						
Private Tutoring						
Chinese	Enrollment in private tutoring =1,	5032	0.10	-	1	0
Math	otherwise =0	5032	0.16	-	1	0
English		5032	0.18	-	1	0
Subject Valuable						
Chinese	Student found subject matter valuable for	5032	0.93	-	1	0
Math	later life =1, otherwise =0	5032	0.90	-	1	0
English		5032	0.87	-	1	0
Frequent Teacher Interaction						
Chinese	Teacher interacted frequently with student	5032	0.64	-	1	0
Math	during instruction =1, otherwise =0	5032	0.63	-	1	0
English		5032	0.67	-	1	0
Panel B: Teacher-Level Variables						
Female	Teacher is female =1, otherwise =0	357	0.73	-	1	0
Homeroom	Teacher is a homeroom teacher =1, otherwise =0	357	0.29	-	1	0

Pre-Service Normal Education	Teacher attended a pre-service normal education teaching program =1, otherwise =0	357	0.93	-	1	0
Certification	Teacher is government certified to teach =1, otherwise =0	357	0.97	-	1	0
Permanent Contract	Teacher is employed on permanent contract =1, otherwise =0	357	0.64	-	1	0
Second-tier or Above Teacher Rank	Teacher received senior, first-tier, second-tier teacher rank =1, otherwise =0	357	0.84	-	1	0
Municipal or Above Teaching Award	Teacher received national, provincial, municipal-level teaching awards =1, otherwise =0	357	0.35	-	1	0
Last Week Working Hours	Teacher's number of working hours last week	357	44.59	12.89	100	12
Teaching Experience	Teaching experience in years	357	14.67	8.67	39	0
Teaching Experience Categories		357				
Group 1	Teaching experience is less than or equal to 5 years =1, otherwise =0		0.18	-	1	0
Group 2	Teaching experience is more than 5 years and less than or equal to 15 years =1, otherwise =0		0.36	-	1	0

Group 3	Teaching experience is more than 15 years and less than or equal to 25 years =1, otherwise =0		0.32	-	1	0
Group 4	Teaching experience is more than 25 years =1, otherwise =0		0.11	-	1	0
Class Assignment by Total Score	Class assigned according to total score =1, not assigned according to total score =0	357	0.28	-	1	0
Class Assignment by Subject Score	Class assigned according to subject score =1, not assigned according to subject score =0	357	0.12	-	1	0
Teacher's Educational Attainment						
Bachelor's Degree and Above	Teacher's highest educational attainment was bachelor's degree or above =1, otherwise =0	357	0.83	-	1	0

Table 4-1-3. ***CEPS Teacher characteristics by subject types (N=357)***

Dependent Variables	Subject (reference = Chinese)	
	Math	English
Bachelor's degree and above (below =0)	-0.046	-.006
	(0.172)	(0.383)
Female (male =0)	-0.593*	0.681*
	(0.151)	(0.197)
Homeroom (non-homeroom =0)	0.264	0.026
	(0.188)	(0.230)
Pre-Service Normal Education (did not attend =0)	0.008	-0.585*
	(0.269)	(0.265)
Permanent Contract (temporary =0)	-0.288	-0.015
	(0.167)	(0.201)
Certification (not certified =0)	0.130	0.558
	(0.385)	(0.464)
Second-tier or Above Teacher Rank (below =0)	0.490*	-0.056
	(0.179)	(0.141)
Municipal or Above Teaching Award (below =0)	0.153	-0.039
	(0.143)	(0.153)
Class Assigned by Subject Score (not assigned by score =0)	0.030	-0.605*
	(0.192)	(0.282)
Teaching Experience (years)	1.714	0.097
	(0.879)	(0.966)
Last Week's Working Hours (hours)	-2.337	-2.221
	(1.804)	(1.698)

Note: Each row represents an independent regression. All coefficients are from probit regression, with exception of Last Week's Working Hours and Teaching Experience, which are from OLS regression. Robust standard errors closeted at the school-level and are presented in parenthesis, * denotes p-value <.05.

In Table 4-1-4, I find that while there are differences in the prevalence of teachers whose highest educational attainment level was at least a 4-year bachelor's compared to those who only received a 2-year associate's or below, there is little evidence that teachers with different education are also systematically different on other observable dimensions. With exception to gender, certification status, and teacher rank, there is no statistical difference between the two groups of teachers on other observable characteristics. Relative to teachers with 2-year associate's or below educational attainment, those with at least a 4-year bachelor's degree are more likely to be female, have obtained certified status, and hold a teacher rank above Level 2.

Table 4-1-4. ***CEPS Teacher characteristics by educational attainment levels (N=357)***

Dependent Variables	Bachelor's degree and above (reference = below)
Female (male =0)	0.778*
	(0.209)
Homeroom (non-homeroom =0)	0.274
	(0.155)
Pre-Service Normal Education (did not attend =0)	0.370
	(0.233)
Permanent Contract (temporary =0)	0.052
	(0.176)
Certification (not certified =0)	0.953*
	(0.279)
Second-tier or Above Teacher Rank (below =0)	0.689*
	(0.213)

Municipal or Above Teaching Award (below =0)	0.252
	(0.213)
Class Assigned by Total Score (not assigned by total score =0)	0.286
	(0.246)
Class Assigned by Subject Score (not assigned by subject score =0)	0.376
	(0.261)
Teaching Experience (years)	-2.314
	(1.604)
Last Week's Working Hours (hours)	-0.923
	(2.412)

Note: Each row represents an independent regression. All coefficients are from probit regression, with exception of Last Week's Working Hours and Teaching Experience, which are from OLS regression. Robust standard errors closeted at the school-level and are presented in parenthesis, * denotes p-value <.05.

To examine the impact of observed teacher quality, specifically a teacher's educational attainment level, on student learning outcomes, I present results from the student fixed-effect models in Table 4-1-5. In the table, I first present a simple model with no baseline control covariates added (Model 1), as well as including results from controlling for teacher-level subject-varying baseline characteristics (Model 2), adding student-level subject-varying baseline variables (Model 3), and finally presenting the full model with both student- and teacher-level subject-varying baseline covariates (Model 4). In Models 5, 6, and 7, I examine the robustness of the results using sensitivity analysis based on detailed information on class-assignment.

First and foremost, in Model 1, results of the simplest specification with just one key variable indicate that students tend to score higher when teachers with bachelor's degrees teach the respective subjects, albeit the impact being not statistically significant. This is to be expected because there may be important subject-varying control covariates that are missing in the specification. In Models 2 and 3 respectively, I add subject-varying baseline teacher and student covariates C_s and $X_{s(t-1)}$, such that subject-varying factors at baseline are accounted for. In effect, C_s represents a vector of controls that include teacher's homeroom status, attendance in pre-service teacher education program, permanent contract status, certification status, teacher rank, teacher award, teaching experience, while X_s contains student-level covariates such as baseline test score, private tutoring enrollment, attitude towards subject and frequency of teacher-student interactions.

Specifically, the key coefficient γ turns statistically significant after the inclusion of C_s and X_s. For Model 2, I find statistically significant impact of 0.046 standard deviations (p-value < 0.05) after adding teacher-level covariates, and 0.033 standard deviations (p-value < 0.05) after adding student-level covariates. In Model 4, where I include the full specification with both student- and teacher-level subject-varying covariates, I continue to find statistically significant impact of 0.033 standard deviations (p-value < 0.05). In other words, holding all else equal, increasing teacher's educational attainment level from 2-year associate's to 4-year bachelor's degree can increase student learning outcome by as much as 0.033 standard deviations, with a 95 percent confidence interval between 0 to 0.068 standard deviations. To put this number in broader context, an impact of 0.033 standard deviations increase in student learning outcomes roughly correspond to 1 additional month of learning in a typical 9-month school year (Kane & Staiger, 2010; OECD, 2016).

For robustness check, I check if ability grouping practices may confound results. After controlling for potential subject-specific classroom assignment, in Model 5, the adjusted result is 0.034 standard deviations and remains statistically significant at the .10-level. In Models 6 and 7, I conduct a further robustness check exercise by limiting the analysis to a sub-sample of which classes are reported by homeroom teachers to have not been assigned by aggregate subject scores. In Model 6, even after limiting to classes that were not sorted, I continue to find statistically significant impacts and the effect size has also doubled to 0.069 standard deviations (p-value < 0.05).

In Model 7, similar observation on the size of impact persists at 0.071 standard deviations (p-value < 0.05), after adding additional control variables on subject-specific class sorting. I interpret these results as showing the robustness of the positive impact that teacher's educational attainment has on student learning. More specifically, this translates to 2 additional months of learning in a typical 9-month school year (Kain & Staiger, 2010; OECD, 2016). In fact, after addressing potentially problematic bias introduced by class sorting practices, the effect sizes are larger than in the overall sample, suggesting that there may have been compensatory assignment of teachers to students, in that some schools have been assigning more-educated teachers to teach low-performing students. These types of sorting of between students and teachers would suggest that existing estimates may be downward biased, and that the true impact of having more educated teachers on student learning may be even larger than observed; potentially twice as large. For interpretation, results with additional controls presented here offer a bounds exercise and identifies upper and lower bounds and potential impacts on learning, that is approximately ranging between 0.03 SDs to 0.07 SDs, or equaling between one to two months of additional learning for a given 9 month academic year.

In Table 4-1-6, as an additional step to identify heterogeneous impacts of teacher educational attainment on student learning, I interact the key variable, 4-year bachelor's, with student baseline characteristics, including student's sex, baseline test scores, minority status, whether she is a "left-behind children" (both parents not living with student), and whether the student reported that her family is experiencing financial hardship. Inclusion of the interaction terms changes the interpretation of the key coefficient γ, which now refers to the impact on the advantaged student population, whereas coefficients for the interaction term correspond to the degree to which disadvantaged students are differentially affected, relative to the advantaged students. In Models 8, 9, 10 and 11 presented in Table 4-1-6, the key coefficient γ is larger than that of the full specification results in Model 4, which is an indication that the impacts on male students, students without low baseline scores, local household registration, and with at least one parent living with them are larger than that of the entire population. However, all interaction terms remain statistically insignificant at the .10-level, which suggest that there is no discernible difference in impact between disadvantaged or advantaged student groups. The results also suggest that increasing teacher's educational attainment from 2-year associate's to 4-year bachelor's seem to be an equitable approach to raising achievement level, such that students with disadvantaged backgrounds benefit no less than other students with more advantaged backgrounds.

Table 4-1-5. ***Impact of teacher educational attainment level on student learning outcomes (Student Fixed-Effects Model)***

Dependent Variable: Follow-up test scores (SDs)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6) Class Assignment by Total Score =0	Model (7)
Teacher-level Variables							
Bachelor's and above (below =0)	0.046	0.041*	0.033*	0.033*	0.034#	0.069*	0.071*
	(0.036)	(0.019)	(0.017)	(0.017)	(0.018)	(0.021)	(0.021)
Homeroom (non-homeroom =0)		0.027#		0.016	0.016	-0.005	-0.004
		(0.016)		(0.014)	(0.015)	(0.016)	(0.017)
Pre-Service Normal Education (otherwise =0)		-0.039#		-0.035	-0.036	-0.067*	-0.083*
		(0.024)		(0.022)	(0.024)	(0.028)	(0.033)
Permanent Contract (temporary =0)		0.001		0.017	0.017	0.008	0.011
		(0.016)		(0.015)	(0.015)	(0.043)	(0.043)
Certification (not certified =0)		-0.007		0.002	0.002	-0.007	-0.007
		(0.047)		(0.043)	(0.043)	(0.017)	(0.017)
Second-tier or Above Teacher Rank (below =0)		-0.016		-0.021	-0.021	0.025	0.032
		(0.029)		(0.027)	(0.027)	(0.034)	(0.035)

Municipal or Above Teaching Award (below =0)	-0.015		-0.015	-0.017	-0.030	-0.037*
	(0.015)		(0.014)	(0.014)	(0.016)	(0.017)
Teaching Experience Group 2 (6-15 years)	-0.003		0.003	0.004	0.034	0.032
	(0.023)		(0.021)	(0.022)	(0.026)	(0.027)
Teaching Experience Group 3 (16-25 years)	0.016		0.032	0.033	0.049*	0.050#
	(0.024)		(0.022)	(0.023)	(0.027)	(0.027)
Teaching Experience Group 4 (>25 years)	-0.012		-0.011	-0.010	0.015	0.013
	(0.029)		(0.027)	(0.027)	(0.031)	(0.032)
Class assigned according to subject scores (not assigned according to subject scores =0)				0.003		0.055
				(0.018)		(0.042)
Student-level Variables						
Baseline test score (SDs)		0.037*	0.037*	0.037*	0.038*	0.038*
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Private Tutoring (not enrolled =0)		0.042*	0.042*	0.043*	0.046*	0.045#
		(0.020)	(0.020)	(0.021)	(0.24)	(0.24)
Subject Valuable (not valuable =0)		0.158*	0.159*	0.154*	0.176*	0.176*
		(0.023)	(0.023)	(0.024)	(0.029)	(0.029)
Frequent Teacher Interaction (otherwise =0)		0.091*	0.090*	0.089*	0.093*	0.093*

			(0.017)	(0.017)	(0.018)	(0.021)	(0.021)
Constant	-0.026	0.029	-2.845*	-2.822*	-2.820*	-2.937*	-2.938*
	(0.030)	(0.053)	(0.067)	(0.082)	(0.084)	(0.096)	(0.097)
Adjusted R-squared	0.659	0.659	0.713	0.713	0.709	0.718	0.7152
Student Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15096	15096	15096	15096	15096	10309	10309

Note: Robust standard errors presented in parenthesis, * denotes p-value <.05, # denotes p-value <.10.

Table 4-1-6. ***Heterogeneous impact of teacher educational attainment level on student learning outcomes, by student baseline characteristics (Student Fixed-Effects Model)***

Dependent Variable: Follow-up test scores (SDs)	Model (8)	Model (9)	Model (10)	Model (11)	Model (12)
Teacher-level Variables					
X Bachelor's and above (below =0)	0.041*	0.039*	0.034#	0.042#	0.027
	(0.024)	(0.018)	(0.019)	(0.023)	(0.020)
Interaction Terms					
X * Student female (male =0)	-0.012				
	(0.034)				
X * Student low baseline score (otherwise =0)		-0.034			
		(0.024)			
X * Non-local household registration (local =0)			-0.037		
			(0.056)		
X * Both parents not living with student (otherwise =0)				0.004	
				(0.044)	
X * Family facing financial hardship (otherwise =0)					0.031
					(0.042)
Constant	-2.833*	-2.771*	-2.829*	-2.787*	-2.820*
	(0.083)	(0.090)	(0.083)	(0.092)	(0.082)
Adjusted R-squared	0.710	0.714	0.713	0.701	0.713
Student-Level Covariates	Yes	Yes	Yes	Yes	Yes

Teacher-Level Covariates	Yes	Yes	Yes	Yes	Yes
Student Fixed-Effects	Yes	Yes	Yes	Yes	Yes
Observations	15096	15096	15096	15096	15096

Note: Robust standard errors in parenthesis, * denotes p-value <.05, # denotes p-value <.10

4.2 Results for Part II:

The Teaching Wage Penalty

As discussed in the literature review section, theoretical implications of adapting Roy (1951) two-sector selection model in teacher labor markets imply that there are two key factors influencing teacher occupational choice decisions:

(1) ratio of wage dispersion between teaching and non-teaching sectors,

(2) correlation between the type of skills valued by teaching and non-teaching sectors

In this regard, if one assumes that labor aptitude and general skills are positively correlated with wage earnings across teaching and non-teaching sectors, an increase in the ratio of earnings dispersion would result in high ability individuals choosing the sector with higher returns to skills and human capital. Therefore, detecting the existence and examining the degree of sector-based wage penalty, in terms of the difference in returns to skills, is crucial to understanding how wage characteristics could potentially affect overall labor force quality in a particular sector. To evaluate whether there exists a wage penalty for teachers and its relative magnitude, the following section utilizes a Mincer function multiple regression approach to identify mean wage gaps between teaching and non-teaching sectors after controlling for important worker characteristics, as well as comparing the degree of heterogeneous returns to human capital and skills. In the remainder of this part, I present further results with discussion on empirical implications.

To begin, I describe background characteristics of the underlying sample population for each wave of CHIP data utilized in this current analysis, as illustrated in Tables 4-2-1 through 4-2-6. By way of organization, I group the descriptive statistics discussion by outcome or variable, and subsequently outline any observed patterns across different waves of CHIP data. First and foremost, as explained in the methodology section, I restrict the analytic sample to all employed individuals between 16 and 60 years old in urban areas, where wage income is available as cash sums for employed individuals, and also because the labor market conditions are arguably comparable across sectors.

Secondly, as the key outcome of interest for the analysis in this section, respondent's weekly wages from primary occupation information are log-transformed, and I apply 1 percent winsoring method to mitigate outlier effects. To this end, I report raw earnings information in local currency (1 yuan is approximately US$0.15) by wave. For the earliest observed wave in 1988, the mean weekly wages is 35.5 yuan (SD=16.2), while the number increases to 109.9 yuan (SD=57.6) in 1995, 261.5 yuan (SD=173.1) in 2002, 579.3 yuan (SD=423) in 2007, 649.3 yuan (SD=467.9) in 2008, and 863.2 yuan (SD=584) in 2013. The average growth in nominal mean wages between 1988 and 2013 was a factor of 24 times, while the wage dispersion as measured by standard deviations grew 1.5 times more at more than 36.5 times. Using urban household consumer price index data available through the National Bureau of Statistics (2018), real mean wage growth was approximately 7 times over the 25 year period, whereas the real wage dispersion grew by about 10.5 times. As noted in both the nominal and real wage growth results, it is observed that while mean wages rose substantially over time, wage dispersion increased at a much quicker pace which indicates expanding wage inequality.

Thirdly, I report teacher and sector identifier categories. Specifically, as CHIP data does not report ISCO or equivalent job-level codes, identification of teachers are based jointly on sectoral, occupational, and work unit ownership information. To this end, teachers are identified as professional workers who are employed in the education sector and working in public institutions (*shiye danwei*); public sector non-teachers are defined as employed individuals who work in either a government agency or public institution and are not teachers, while private sector non-teaching includes all employed individuals in the private sector. Unfortunately, due to data availability, I am not able to distinguish between levels of instruction for teachers; however, because teachers who work in primary and secondary education represent by far the largest worker population within the teaching force, they are likely to be oversampled in my identification of teachers. Therefore, it is not unreasonable to assume that a substantial majority of identified teachers work in primary and secondary settings. In further detail, identified teachers consist of between 3 to 5 percent of the total sample across years, approximately three in five respondents are private sector non-teachers and about a quarter are public sector non-teachers. Across all available years, labor force composition by this classification does not fluctuate much, but with one exception, such that there were disproportionately more public sector non-teacher workers in 1988 (74 percent), about three times the amount of private sector workers. This number reversed in 1995 and stabilized through the rest of the data years.

Fourthly, educational attainment levels are grouped into three categories to improve comparability over time; such that individuals with a 4-year university education (*benke*) or any post-graduate degree (*yanjiusheng*) are classified as having obtained at least a

Bachelor's degree, whereas the group "Associate's" refer exclusively to those who have completed high school education and obtained a 2-year post-secondary education (*dazhuan*). In addition, individuals with no education or attended some level of education below upper secondary are all grouped together. Across years and also across sectors, the average educational attainment level is on the rise, with gradually more individuals falling into the Associate's or Bachelor's and above categories. More specifically, there were only 6 and 7 percent of the sample with Bachelor's and above or Associate's educational levels in 1988 respectively; this number rose over time to 13 percent and 29 percent in 2002, and finally reaching 24 percent and 23 percent in 2013. However, most of the recent growth was observed in the Bachelor's and above category, while the percent of individuals with Associate's increased to 29 percent in as recent as 2007 before beginning to decline in 2008.

Finally, the samples appear to be relatively stable across most domains of individual characteristics over time. Overall, the average age, work experience, sex, marital status, minority status of respondents indicates a very tight range across years, only differencing very slightly. For instance, average age across years only differed very little, CHIP2002 having the oldest sample (40.23 years old) and CHIP1988 with the youngest cohort (36.61 years old). Female representation was slightly less than half in all samples, ranging from 47 percent in 2007 to 48 percent in 1988. Across years, information on single and minority status is approximately reported at around 10 to 15 percent and 1 to 5 percent respectively; party membership is identified to range between 20 and 30 percent. Last but not least, it is observed that the share of tenured workers fluctuates substantially across years, from as low as 51 percent in 2002 to almost covering the full sample (98 percent) in 1988.

Table 4-2-1. ***Descriptive Statistics of 1988 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	17073	35.45	16.16	95	0.25
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	17073	0.04	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	17073	0.74	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	17073	0.22	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	17073	0.06	-	1	0
Associate's	Highest educational attainment was associate's degree =1, otherwise =0	17073	0.07	-	1	0
Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	17073	0.87	-	1	0
Background Characteristics						
Age	Age in Years	17073	36.61	9.91	16	60
Years of Work Experience	Work Experience in Years	17073	19.24	9.97	0	40
Female	Female =1, male =0	17073	0.48	-	1	0
Minority	Minority =1, otherwise =0	17073	0.04	-	1	0

Party Membership	Party member =1, otherwise =0	17073	0.23	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	17073	0.97	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

Table 4-2-2. ***Descriptive Statistics of 1995 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	10756	109.86	57.62	325	11.5
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	10756	0.04	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	10756	0.28	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	10756	0.68	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	10756	0.08	-	1	0
Associate's	Highest educational attainment was associate's degree =1, otherwise =0	10756	0.16	-	1	0

Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	10756	0.76	-	1	0
Background Characteristics						
Age	Age in Years	10756	38.4	9.22	60	16
Years of Work Experience	Work Experience in Years	10756	19.32	9.28	40	0
Female	Female =1, male =0	10756	0.47	-	1	0
Single	Single =1, otherwise =0	10756	0.12	-	1	0
Minority	Minority =1, otherwise =0	10756	0.04	-	1	0
Party Membership	Party member =1, otherwise =0	10756	0.25	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	10756	0.77	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

Table 4-2-3. ***Descriptive Statistics of 2002 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	9762	261.5	173.13	983	35
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	9762	0.05	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	9762	0.31	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	9762	0.64	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	9762	0.13	-	1	0
Associate's	Highest educational attainment was associate's degree =1, otherwise =0	9762	0.29	-	1	0
Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	9762	0.58	-	1	0
Background Characteristics						
Age	Age in Years	9762	40.23	8.81	60	18
Years of Work Experience	Work Experience in Years	9762	21.87	9.32	40	0
Female	Female =1, male =0	9762	0.45	-	1	0
Single	Single =1, otherwise =0	9762	0.10	-	1	0

Minority	Minority =1, otherwise =0	9762	0.04	-	1	0
Party Membership	Party member =1, otherwise =0	9762	0.29	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	9762	0.51	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

Table 4-2-4. ***Descriptive Statistics of 2007 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	5465	579.3	422.97	2499.8	87.5
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	5465	0.03	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	5465	0.29	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	5465	0.68	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	5465	0.17	-	1	0

Associate's	Highest educational attainment was associate's degree =1, otherwise =0	5465	0.29	-	1	0
Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	5465	0.54	-	1	0
Background Characteristics						
Age	Age in Years	5465	38.69	9.2	60	18
Years of Work Experience	Work Experience in Years	5465	19.73	10.28	40	0
Female	Female =1, male =0	5465	0.43	-	1	0
Single	Single =1, otherwise =0	5465	0.14	-	1	0
Minority	Minority =1, otherwise =0	5465	0.01	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	5465	0.77	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

Table 4-2-5. ***Descriptive Statistics of 2008 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	5452	649.31	467.91	2500	100
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	5452	0.03	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	5452	0.31	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	5452	0.66	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	5452	0.23	-	1	0
Associate's	Highest educational attainment was associate's degree =1, otherwise =0	5452	0.29	-	1	0
Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	5452	0.48	-	1	0
Background Characteristics						
Age	Age in Years	5452	39.33	9.32	60	18
Years of Work Experience	Work Experience in Years	5452	20.34	10.51	40	0
Female	Female =1, male =0	5452	0.45	-	1	0
Single	Single =1, otherwise =0	5452	0.14	-	1	0

Minority	Minority =1, otherwise =0	5452	0.01	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	5452	0.77	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

Table 4-2-6. ***Descriptive Statistics of 2013 CHIP Urban Labor Market Participant Sample***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Labor Market Outcomes						
Weekly Wages	Weekly Earnings in Yuan	7811	863.21	584.05	3350	50
Teacher and Sector Identifiers						
Teacher	Teacher =1, otherwise =0	7811	0.05	-	1	0
Public Sector Non-Teachers	Public Sector Non-Teachers =1, otherwise =0	7811	0.2	-	1	0
Private Sector Non-Teachers	Private Sector Non-Teachers =1, otherwise =0	7811	0.74	-	1	0
Education Attainment Level						
Bachelor's & Above	Highest educational attainment was bachelor's degree or above =1, otherwise =0	7811	0.24	-	1	0
Associate's	Highest educational attainment was associate's degree =1, otherwise =0	7811	0.23	-	1	0

Upper Secondary & Below	Highest educational attainment was upper secondary or below =1, otherwise =0	7811	0.53	-	1	0
Background Characteristics						
Age	Age in Years	7811	39.8	9.17	60	16
Years of Work Experience	Work Experience in Years	7811	21.13	10.13	40	0
Female	Female =1, male =0	7811	0.45	-	1	0
Single	Single =1, otherwise =0	7811	0.11	-	1	0
Minority	Minority =1, otherwise =0	7811	0.05	-	1	0
Party Membership	Party member =1, otherwise =0	7811	0.21	-	1	0
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	7811	0.59	-	1	0

Note: The sample is restricted to all employed individuals between the age of 16 and 60 years old, with at most 40 years of working experience. Winsoring adjustment has been applied to weekly wages for top and bottom 1 percent.

In Tables 4-2-7 and 4-2-8, I report the regression adjusted mean wage differences and the differential returns to skills and education across sectors. To begin, each column represents an independent regression model using different waves of the repeated cross-sectional CHIP data, such that Models (1) through Model (6) each correspond to a respective wave of CHIP 1988, 1995, 2002, 2007, 2008, or 2013. The first and second rows in Table 4-2-7 respectively correspond to coefficients β_2 and β_3 in Equation (2.2), which indicate the regression-adjusted mean wage differences in natural log points between teachers and private or public sector non-teaching workers, after controlling for important background and demographics covariates. The subsequent rows show point estimates for each control covariate that entered the regression analysis, and importantly, all models include birth cohort and worker type fixed-effect dummies as additional controls. To this end, this exercise aims to detect the existence and quantify the degree of sector-based mean wage differences, and several important insights on sectoral wage characteristics can be summarized from results in Table 4-2-7.

Firstly, point estimate results for β_2 are statistically significant across all years with exception of 2007, and the coefficients which indicate the mean wage differences are respectively -0.129 (p-value <0.05), -0.068 (p-value <0.05), -0.180 (p-value <0.05), 0.036, 0.099 (p-value <0.05), and 0.112 (p-value <0.05) log points. These results illustrate that between 1988 and 2013, the regression-adjusted mean wage difference between teachers and private non-teaching workers has changed from approximately 13 percent in favor of teachers in 1988, which began reducing over time and eventually reversed to about 11 percent benefitting private non-teaching workers in 2013. This drastic shift represented a

24 percentage point reversal. To be clear, this means that teachers' mean wage levels were about 13 percent higher than that of comparable private sector workers in 1988, but this wage premium gradually dissipated, such that in 2007 there was no statistical difference between teacher and private sector worker wages, but the gap reversed, and in 2013 teachers are on average paid about 11 percent less than similar private sector workers. Nonetheless, such observations are expected as rapid economic developments in the private sector can result in new employment opportunities arising that are more responsive to market forces (Zhao & Zhou, 2007)

Secondly, results for β_3, which subsequently indicate the difference in mean wages between teachers and comparable public sector workers, are either not statistically significant or relatively small when they are marginally significant. To illustrate, significant differences in mean wages are only observed in 1988 and 2008, when public sector worker wages are paid about 4 percent (p-value <0.05) and 9 percent (p-value <0.10) higher than teachers respectively. Overall, there seems to be a general pattern indicating that mean wages for comparable workers in the public sector have been somewhat similar to that of teachers, whereas private sector wages have expanded considerable for workers who are similarly qualified as teachers.

Thirdly, the estimated coefficients on a few important control covariates are also worth mentioning for more contextual understanding of broader labor market conditions in China during this time period. For one, coefficients for "*Bachelor's & Above*" only became consistently significant in the 2007, 2008, 2013 waves, suggesting that the returns to

Bachelor's degree and Associate's degree are statistically similar in earlier years, after accounting for sector and other background variables. Before 2007, there were no discernible wage benefits to obtaining advanced tertiary education. For another, female workers have been consistently undervalued relative to comparable male counter parts across all years, and the gender wage gap has been expanding much more recently, reaching a staggering -23.6 percent in 2013 from a marginally significant -2.1 percent in 1988.

Table 4-2-7. ***Regression Results from Mincer Earnings Function, by year***

Year	1988	1995	2002	2007	2008	2013
Dependent Variable:	Model	Model	Model	Model	Model	Model
Log Weekly Wages	(1)	(2)	(3)	(4)	(5)	(6)
Adjusted Mean Wage Difference						
Private Non-Teachers	-0.129*	-0.068*	-0.180*	0.036	0.099*	0.112*
(reference = teachers)	(0.031)	(0.022)	(0.034)	(0.042)	(0.04)	(0.049)
Public Non-Teachers	0.039*	0.009	-0.081	0.017	0.091#	-0.021
(reference = teachers)	(0.014)	(0.027)	(0.025)	(0.047)	(0.047)	(0.040)
Control Covariates						
Bachelor's & Above	0.010	0.090*	-0.014	0.155*	0.212*	0.185*
(reference = associate's)	(0.007)	(0.025)	(0.036)	(0.035)	(0.020)	(0.022)
Upper Secondary &	0.029	-0.086*	0.077#	-0.144*	-0.232*	-0.060#
Below (reference = associate's)	(0.027)	(0.015)	(0.027)	(0.052)	(0.026)	(0.029)
Years of Work Experience	-0.001	0.032*	-0.096*	0.011	0.011#	-0.017
	(0.013)	(0.004)	(0.017)	(0.017)	(0.005)	(0.014)

Years of Work Experience Squared	-0.001*	-0.001*	-0.000#	-0.001*	-0.001*	-0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	-0.021#	-0.115*	-0.161*	-0.260*	-0.246*	-0.237*
	(0.012)	(0.016)	(0.021)	(0.025)	(0.016)	(0.021)
Single	-	0.004	0.006	-0.096	-0.137#	-0.012
	-	(0.054)	(0.055)	(0.064)	(0.070)	(0.038)
Minority	-0.041	-0.069	0.029	-0.200	-0.222*	-0.109#
	(0.033)	(0.042)	(0.034)	(0.124)	(0.081)	(0.050)
Party Membership	0.059*	0.063*	0.036#	-	-	0.011
	(0.010)	(0.020)	(0.019)	-	-	(0.026)
Permanent Contract	1.318*	0.029	0.050	0.194*	0.165*	0.264*
	(0.094)	(0.029)	(0.049)	(0.056)	(0.049)	(0.028)
Fixed-effect Dummies						
Birth Cohorts	Yes	Yes	Yes	Yes	Yes	Yes
Worker Type	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.851*	4.119*	7.556*	6.518*	6.238*	7.318*
	(0.187)	(0.107)	(0.354)	(0.291)	(0.137)	(0.248)
Adjusted R-squared	0.4609	0.2255	0.2234	0.2139	0.2902	0.2237
Observations	17073	10756	7701	5465	5452	7811

Note: Individual information on single status in CHIP1988 and party membership information in CHIP2007, 2008 are not available, therefore models omitted these covariates. Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10.

Next, in Table 4-2-8, I turn to the expanded Mincer function regression, as illustrated in Equation (2.3), which has incorporated the interaction terms between sector of employment and educational attainment level. With the inclusion of interaction terms, interpretation of the coefficients β_2 and β_3 has changed, which will now be referred to as the mean wage differences for non-Bachelor's degree holders between teachers and public or private sector non-teaching workers respectively. Consequently, β_5 and β_6 will indicate the differential returns to having a Bachelor's degree in teaching versus returns in the private and public sectors respectively. Keeping these interpretations in mind, I focus on results in Table 4-2-8, where the first row corresponds to β_5, or the difference in returns to having a Bachelor's degree for teachers versus private sector non-teacher workers, whereas the second row represents point estimates for β_6, that is the difference in returns to having a Bachelor's degree for teachers versus public sector non-teacher workers. The mean wage differences for non-Bachelor's degree holders between teachers and private or public sector non-teaching workers are in rows three and four of Table 4-2-8 respectively.

Point estimates of coefficients β_5 as represented in the first row of Table 4-2-8, show that there is some suggestion that returns to additional human capital accumulation are higher for comparable private sector workers than teachers between 1988, 1995 and 2002, but the two groups are not statistically significant. However, in more recent years such as 2007, 2008, and 2013, results have become statistically significant which indicate that returns to Bachelor's and more education are higher for comparable private sector workers, respectively 15.8, 11.3, and 13.5 percent more. Results in the second row correspond to β_6 estimates, which illustrate the relationship between returns to more education among public sector non-teaching workers and teachers. Broadly speaking, differences in returns on education for these two groups are either statistically indistinguishable or much smaller in relative magnitudes compared to the differences observed between private sector workers and teachers.

In summary, patterns observed in Table 4-2-8 are to a large extent similar to that of Table 4-2-7, in that wage characteristics, in terms of mean wages and returns to human capital, are at least similar if not more favorable for teachers relative to comparable private sector workers in the earlier years 1988, 1995, 2002. On the other hand, sharp contrasts in results for 2007, 2008, and 2013 waves are observed, such that not only teachers' mean wages were about 10 percent less than that of comparable private workers, the returns to education estimates also show that teachers are at a 11 to 15 percent disadvantage compared to similar private sector workers. As for the comparison between teachers and similarly qualified public sector workers, differences in mean wages and returns to human capital are negligible across years, either being statistically insignificant or at much smaller magnitude.

As robustness check, in Table 4-2-9, I take advantage of the available household-level linked information on respondent's father and mother educational attainment level to evaluate the sensitivity of results presented in Tables 4-2-7 and 4-2-8. Specifically, for Models 12 and 14, I add father's and mother's educational attainment level controls to the base and full specifications to mitigate potential biases in individual's section into higher educational attainment, and directly compare the results with that of Models 6 and 13. In detail, Model 13 evaluates the soundness of results in Model 6 with added parental education level controls, whereas Model 14 is directly comparable with Model 12. Indicated by the comparison of β_2 estimates in Model 6 and 13, reduction of the coefficient by half and becoming statistically insignificant suggest that there are some concerns with endogeneity of individual's decision into private or teaching sectors being influenced in part by parental educational attainment level. However, in Models 12 and 14,

β_5 estimates are consistent across models which provide some assurance that the differential returns to education results observed in private and teaching sectors are not substantially driven by parental education. Overall, the robustness test suggests that results for β_5 in Table 4-2-8 continue to hold true even with additional household level control covariates included.

Finally, the above results have important theoretical implications through the lens of teacher occupational choice framework. For instance, if one assumes that worker aptitude and general skills are positively correlated with earnings across different sectors, a rise in the difference in returns to human capital and skills would imply that individuals would choose the sector with higher returns. The empirical results observed in Part II suggest that returns to more education in the teaching sector have substantially lagged behind that of the private sector, even for workers with comparable characteristics. After accounting for important individual characteristics, persistence of such pay differences imply that by choosing the teaching sector, a well-educated individual would not be rewarded for her skills and human capital, as she would otherwise in the private sector. This finding shows that in recent years, teaching has become much less attractive career in comparison to working in the private sector for individuals with advanced tertiary education. If sustained over a long period of time, the teacher occupational choice framework predicts that average teacher ability would decline, because as teaching becomes an occupation without attractive income, well-educated individuals are predicted to pursue higher returns on their human capital and skills in the better paying private sector.

Table 4-2-8. ***Regression Results from Mincer Earnings Function with Interaction Terms, by year***

Year	1988	1995	2002	2007	2008	2013
	Model	Model	Model	Model	Model	Model
Dependent Variable: Log Weekly Wages	(7)	(8)	(9)	(10)	(11)	(12)
Interaction Terms						
	0.111	0.010	0.065	0.158#	0.113#	0.135*
Private Non-Teachers * Bachelor's & Above	(0.077)	(0.059)	(0.071)	(0.070)	(0.049)	(0.057)
	-0.008	-0.047	-0.036	0.082	0.099#	0.044
Public Non-Teachers * Bachelor's & Above	(0.013)	(0.032)	(0.076)	(0.071)	(0.053)	(0.064)
Adjusted Mean Wage Difference						
Private Non-Teachers	-0.129*	-0.063*	-0.192*	-0.019	0.027	0.053
(reference = teachers)	(0.031)	(0.023)	(0.035)	(0.042)	(0.072)	(0.059)
Public Non-Teachers	0.040*	0.020	-0.081*	-0.023	0.023	-0.065
(reference = teachers)	(0.013)	(0.022)	(0.031)	(0.047)	(0.072)	(0.060)
Educational Attainment						
Bachelor's & Above	0.013	0.111*	-0.22	0.035	0.111*	0.097
(reference = associate's)	(0.017)	(0.039)	(0.064)	(0.062)	(0.031)	(0.056)
Upper Secondary & Below	0.029	-0.086*	0.078*	-0.139*	-0.231*	-0.050
(reference = associate's)	(0.027)	(0.016)	(0.021)	(0.051)	(0.026)	(0.029)

Control Covariates	Yes	Yes	Yes	Yes	Yes	Yes
Fixed-effect Dummies						
Birth Cohorts	Yes	Yes	Yes	Yes	Yes	Yes
Worker Type	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.849*	4.112*	7.545*	6.570*	6.309*	7.366*
	(0.186)	(0.104)	(0.290)	(0.283)	(0.132)	(0.263)
Adjusted R-squared	0.4609	0.2212	0.2399	0.2143	0.2901	0.2243
Observations	17073	10756	7701	5465	5452	7811

Note: Individual information on single status in CHIP1988 and party membership information in CHIP2007, 2008 are not available, therefore models omitted these covariates. Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10. Control covariates and model specifications are identical with Table 4-2-7, such that point estimates from Models 1 & 7, 2 & 8, 3 & 9, 4 & 10, 5 & 11, 6 & 12, are directly comparable.

Table 4-2-9. ***Robustness Check for Mincer Earnings Function, using CHIP 2013***

Year	2013			
Dependent Variable: Log Weekly Wages	Model (6)	Model (12)	Model (13)	Model (14)
Interaction Terms				
Private Non-Teachers * Bachelor's & Above		0.136* (0.057)		0.132* (0.051)
Public Non-Teachers * Bachelor's & Above		0.044 (0.064)		0.056 (0.059)
Adjusted Mean Wage Difference				
Private Non-Teachers (reference = teachers)	0.112* (0.049)	0.053 (0.059)	0.067 (0.050)	0.012 (0.066)
Public Non-Teachers (reference = teachers)	-0.021 (0.040)	-0.065 (0.060)	-0.043 (0.040)	-0.094 (0.061)
Educational Attainment				
Bachelor's & Above (reference = associate's)	0.185* (0.022)	0.097 (0.056)	0.153* (0.024)	0.065 (0.055)
Upper Secondary & Below (reference = associate's)	-0.060# (0.029)	-0.050 (0.029)	-0.069# (0.033)	-0.059 (0.034)
Additional Control Covariates				
Father's Education Level	No	No	Yes	Yes
Mother's Education Level	No	No	Yes	Yes
All Control Covariates In Table 4-2-7 & 4-2-8	Yes	Yes	Yes	Yes
Fixed-effect Dummies				
Birth Cohorts	Yes	Yes	Yes	Yes
Worker Type	Yes	Yes	Yes	Yes
Constant	7.336* (0.248)	7.355* (0.266)	7.241* (0.259)	7.260* (0.275)

Adjusted R-squared	0.2239	0.2243	0.2262	0.2263
Observations	7811	7811	7811	7811

Note: Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10.

4.3 Results for Part III:

Teacher Quality and Occupational Trends

Since 1980, each of the Chinese central government's quinquennial national policy plan has featured a the importance of building a high-quality teaching force, and this emphasis on recruiting and maintaining high teacher standards have been reiterated again in the most recent "Thirteen-Five National Education Plan" (State Council, 2017). As the current national plan states, one of the key issues limiting development in China's education sector is the "quality and composition of the teaching force" (State Council, 2017, Section 1), and the plan subsequently lists the "improvement of teacher quality" as a primary objective in the "Thirteen-Five" period before 2020 (State Council, 2017, Section 4). The research objective of Part III is to analyze teacher's occupational decisions based on their human capital traits, and track trends in relative labor quality between teacher and non-teachers using observed career decisions to approximate revealed occupational preferences among current workers in the labor force.

More specifically, I estimate a multinomial probit model to relate measures of labor quality and human capital – educational attainment level, upper secondary school selectivity, national college entrance exam scores – to observed occupational choice decisions in teaching, public non-teaching or private non-teaching careers. To further ensure comparability among different career outcomes, I restrict the analysis to the professional worker subsample within each wave of CHIP data, such that employed workers who self-reported as owner, manger, and laborer are excluded from the regression analysis.

For further elaboration, the educational attainment level variable used for this analysis will be identical for all waves of CHIP data (see Tables 4-2-1 through 4-2-6 for more information), whereas descriptive statistics on upper secondary school selectivity and national college entrance exam (*gaokao*) scores are illustrated further in Table 4-3-1. Data on upper secondary school selectivity and national college entrance exam scores are limited to more recent waves of CHIP in 2002, 2007 and 2013. For example, in Panel A of Table 4-3-1, I show share of individuals in the sample by the selectivity of the upper secondary school that they have attended. Approximately 8 percent of the CHIP2002 professional-only analytic sample report having attended a "National & Provincial Key School" which represents the most selective category, while the same numbers are 36 percent for "Municipal & County Key School," and the majority 57 percent attended none of the above categories (least selective). For CHIP2007, only national college entrance exam scores are reported (see Panel B, Table 4-3-1), which had a subsample mean of 469 points (SD=107). In Panel C of Table 4-3-1, information on both upper secondary school selectivity and national college entrance exam scores are provided in CHIP2013, such that there are 6 percent in the most selective national and provincial key schools category, 44 percent in municipal or county-level key schools, and 50 percent in the least selective category; mean scores for the national college entrance exam is 466 points (SD=99).

Table 4-3-1. ***Descriptive Statistics of CHIP Urban Labor Market Participant Ability Characteristics (Professional Workers Only), by year***

Variable	Definition and Metrics	N	Mean	SD	Max	Min
Panel A | CHIP2002						
High School Selectivity						
National & Provincial Key	Attended a national or provincial key school =1, otherwise =0	1864	0.08	-	1	0
Municipal & County Key	Attended a municipal or county key school =1, otherwise =0	1864	0.36	-	1	0
Not Key or Other	Attended a non-key high school, or other =1, otherwise =0	1864	0.57	-	1	0
Panel B | CHIP2007						
Gaokao Score	National College Entrance Examination Score	669	469	107	817	30
Panel C | CHIP2013						
High School Selectivity						
National & Provincial Key	Attended a national or provincial key school =1, otherwise =0	1763	0.06	-	1	0
Municipal & County Key	Attended a municipal-level key high school =1, otherwise =0	1763	0.44	-	1	0
Not Key or Other	Attended a county-level key high school =1, otherwise =0	1763	0.50	-	1	0
Gaokao Score	National College Entrance Examination Score	1005	466	99	730	58

In Table 4-3-2, I turn to the multinomial probit regression results, which are separately reported in each column for each model's coefficient as well as the marginal effect for each educational attainment level (relative to the reference category: Associate's). For instance, Columns 1 and 2 correspond respectively to the "Beta" coefficient and "Marginal Effect" estimates from Model 1 that is fitted on the CHIP1988 professional worker subsample. Consequently, the fifth and ninth row of "Beta" column results in Table 4-3-2 represent the estimated relationship between obtaining at least a Bachelor's degree (reference category is Associate's degree), or only Upper Secondary or below (reference category is Associate's degree), on the probability of choosing to be a worker in the private sector relative to choosing teaching. A negative coefficient in these rows suggests that being a teacher is more likely predicted than working in the private sector, for a set of educational attainment level. In the same vein, "Beta" column results in rows seven and eleven of Table 4-3-2 relate to the same probabilities and are interpreted in the same way, but the relationship is subsequently between public sector careers and teaching. The "M. Effect" column represents the marginal effect of holding a given degree versus the reference category on the predicted probability of choosing a particular career option: teaching, private sector, or public sector.

For interpretation, a positive and statistically significant coefficient in the "Beta" column indicates that the receipt of a given degree (Bachelor's in rows 5 and rows 9, or Upper Secondary or Below in rows 7 and 11) is associated with higher predicted probability of choosing teaching as a career, compared to either private or public sector professional jobs; a negative and statistically significant coefficient indicates the reverse relationship. In the

"M. Effect" column, a statistically significant point estimate indicates the conditional probability change in choosing a given career that is related to one unit change in the explanatory variable; for "Bachelor's & Above" this refers to holding at least a bachelor's degree. For all cells, the reference group is for workers who hold an associate's degree.

To begin, generalizing from results shown in Table 4-3-2, more educated professional workers are more likely to choose a career in teaching as opposed to working in private or public sector non-teaching jobs. For instance, taking a closer look at the "Beta" column in the fifth row of Table 4-3-2, we can observe a consistent trend across all models and years that between 1988 and 2013, coefficients are always negative and statistically significant (coefficient was marginally significant at .10-level in 1988, for all other years p-value<.05). This means that across all years, it is more likely for professional workers with Bachelor's degrees or above (relative to those with Associate's degrees) to choose teaching over working in the private sector, after controlling for a vector of important demographic characteristics. Similarly, in row seven, it is more likely for professional workers with an Associate's degree to be a teacher than to work in the private sector.

Also, results from "Beta" column in rows nine and eleven, which represent the probability of choosing public sector relative to teaching jobs, show that workers with higher education attainment tend to favor teaching careers relative to public sector jobs, especially in the 2002, 2007, and 2013 waves. Importantly, while Bachelor's degree attainment does not seem to influence likelihood of choosing teaching over public sector careers in 1988 and 1995, as indicated by the insignificant "Beta" coefficients -0.137 and -0.101, workers with

Bachelor's degrees are more likely to choose teaching rather than other public sector jobs in later waves since the "Beta" coefficients become negative and significant -0.521 (p-value<.05), -0.242 (p-value<.10), and -0.361 (p-value<.05) in Models 3, 4, 5 respectively.

Secondly, in order to evaluate the magnitude of observed relationships above, I turn to the "M. Effects" column in Table 4-3-2. Using Model 1 as example, in the first row I find that in 1988, having attained at least a Bachelor's degree is on average correlated with a 3 percent increase in the probability of entering teaching, relative to only obtaining an associate's degree, but this relationship is not statistically significant. The same relationship is 7.6 percent, 10.8 percent, 6.3 percent and 8.7 percent for Models 2, 3, 4, 5 respectively. These findings are not surprising, and to a large extent corroborate the macro-level accounting exercise carried out at the outset of this chapter, in Table 4-0-2, which showed that the percent of teachers with advanced tertiary education degrees increased substantially and at a quicker pace than the national average between period 2003 and 2017.

As a third step, in Table 4-3-3, I distinguish the differential quality occupation decision patterns in teacher stock and teacher flow, by reporting Adjusted Predictions at Representative Values (APRV) for individuals whose age are 30 and 50 years old respectively. The APRV of Bachelor's degree attainment on the probability of choosing to be a teacher conditional on age equals 30 will illustrate the career decisions of new labor market entrants, while the APRV results conditional age equals 50 will approximate the existing stock of the teaching force. For instance, in 2013, new entrants who hold a Bachelor's degree are about 4.5 percent more likely to become a teacher relative to another new entrant who holds an Associate's degree, but this number was 10.3 percent more likely for older cohorts.

To this end, I evaluate the differences in APRVs between new entrants and existing labor force, such that a negative and statically significant difference between the two APRVs will indicate that more educated new labor market entrants are less likely to become a teacher compared to the existing cohort. Indeed, in Table 4-3-3, I find negative and statistically significant differences in the marginal effect between new entrants and existing workers in recent waves 2007 and 2013, and these deficits are -4.7 percentage points (p-value<.0.5) and -5.8 percentage points (p-value<.05) respectively, representing a difference of more than 50 percent between the two groups. To be clear, this means that new workers with Bachelor's degrees are about half as likely to choose teaching as compared to older cohorts. Relating these observations to results shown for 1988, 1995 and 2002, I conclude that while more educated new labor market entrants are about as likely or more likely to become teachers between 1988 and 2002 compared to more senior cohorts in the existing labor force, more educated individuals are less likely relative to more senior cohorts to choose teaching as a career in 2007 and 2013.

Table 4-3-2. ***Multinomial Probit Regression Results of the Relationship between Educational Attainment Level and Career Decision Outcome ("Teacher" as omitted base category), with Marginal Effects on Predicted Probabilities by Outcome, 1988 -2013 Professional Worker Subsample***

		Model 1		Model 2		Model 3		Model 4		Model 5	
	Year	1988		1995		2002		2007		2013	
Career Outcomes	(Ref = AA's)	Beta	M. Effect	Beta	M. Effect	Beta	M. Effect	Beta	M. Effect	Beta	M. Effect
Omitted Category: Teacher	Bachelor's & Above	-	0.030	-	0.076*	-	0.108*	-	0.063*	-	0.087*
		-	(0.029)	-	(0.028)	-	(0.026)	-	(0.023)	-	(0.027)
	Upper Secondary & Below	-	-0.121*	-	-0.054*	-	-0.139*	-	-0.107*	-	-0.119*
		-	(0.016)	-	(0.015)	-	(0.015)	-	(0.025)	-	(0.034)
Private Non-teaching	Bachelor's & Above	-0.597#	-0.054#	-0.653*	-0.166*	-0.507*	-0.053#	-0.458*	-0.084#	-0.504*	-0.077*
		(0.310)	(0.030)	(0.146)	(0.031)	(0.137)	(0.029)	(0.158)	(0.044)	(0.123)	(0.027)
	Upper Secondary & Below	0.732*	0.040*	0.344*	0.052*	0.786*	0.098*	0.882*	0.145*	0.928*	0.188*
		(0.158)	(0.017)	(0.072)	(0.017)	(0.111)	(0.025)	(0.151)	(0.024)	(0.206)	(0.031)
Public Non-teaching	Bachelor's & Above	-0.137	0.024	-0.101	0.089*	-0.521*	-0.055*	-0.242#	0.021	-0.361*	-0.010
		(0.097)	(0.019)	(0.142)	(0.032)	(0.112)	(0.024)	(0.138)	(0.040)	(0.190)	(0.037)

Upper Secondary & Below	0.440*	0.081*	0.243*	0.002	0.653*	0.041#	0.515*	-0.037	0.333#	-0.069*
	(0.086)	(0.026)	(0.110)	(0.023)	(0.116)	(0.024)	(0.207)	(0.029)	(0.202)	(0.027)
Control Covariates	Yes		Yes		Yes		Yes		Yes	
Number of Observations	2695		2456		2036		1343		2132	
Number of Teacher Observations	779		441		505		207		429	
Percent Teachers	0.29		0.18		0.25		0.15		0.20	

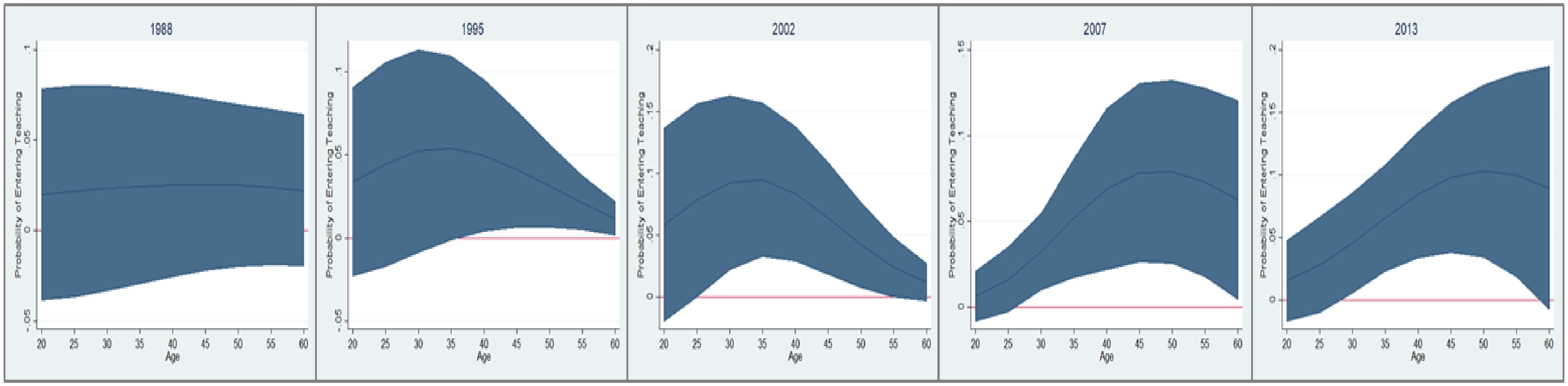
Note: Robust standard errors in parenthesis and are clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10. Control covariates include respondent's sex, age, quadratic age, minority status, party membership status, permanent contract status. Marginal effects (dy/dx) and associated robust standard errors (in parenthesis) are calculated based on delta-method.

Table 4-3-3. ***Marginal Effect, Multinomial Probit Regression Results of the Relationship between Bachelor's Degree Attainment (Ref = Associate's) on Predicted Probabilities of Being a Teacher, at Representative Ages 30 and 50***

	M. Effect at Age 30	M. Effect at Age 50	Difference
1988	0.023	0.025	-0.002
(Model 1)	(0.029)	(0.023)	(0.018)
1995	0.052#	0.031*	0.021
(Model 2)	(0.031)	(0.013)	(0.028)
2002	0.093*	0.042*	0.051#
(Model 3)	(0.036)	(0.017)	(0.032)
2007	0.032*	0.079*	-0.047*
(Model 4)	(0.011)	(0.027)	(0.025)
2013	0.045*	0.103*	-0.058*
(Model 5)	(0.020)	(0.035)	(0.029)

Note: Marginal effects (dy/dx) and robust standard errors (in parenthesis) are calculated using delta-method. Following Clogg, Petkova, and Haritou (1995), a z-test comparison of coefficients is used, * denotes p-value <.05, # denotes p-value <.10.

Figure 4-3-1. ***Distribution of the Marginal Effect of Bachelor's Degree (ref=Associate's) on Predicted Probabilities of Being a Teacher, by Age, 1988-2013***



Source: Author's compilation. Note: y-axis is the marginal effect of having a Bachelor's degree relative to having an Associate's degree on the predicted probability of being a teacher; x-axis is age with a band of 20 to 60 years old. Predicted probability of zero is marked by a horizontal red line.

A visual representation of how this probability changes over time is illustrated in Figure 4-3-1, such that from left to right, each panel offers a glimpse of the full distribution of marginal effect of educational attainment by age for each wave of data. Within each panel, age is the running variable on the x-axis with younger cohorts on the left and older cohorts to the right. Across time, we can see that the distribution of marginal effects has gradually become left-skewed, suggesting that younger cohorts are less likely than older cohorts to enter teaching, when they are more educated. Taken altogether, the interpretation of results from Tables 4-3-2, 4-3-3 and Figure 4-3-1 reveals that being more educated is generally associated with a higher probability of becoming a teacher, but in recent years 2007 and 2013, this relationship has become weaker among new workers, and indicates a potentially large decline in relative labor quality among new teacher entrants when compared to the workforce in non-teaching sectors.

To further confirm the observed trends and check for the robustness of using educational attainment level as proxy for human capital and general skills levels, I conduct two additional analyses with different types of human capital measures: upper secondary selectivity and national college entrance exam scores. To this end, these two pre-labor market human capital measures are proxies for general worker aptitude, and are intended to be interpreted broadly as guidance information on the relative placement of individuals on the labor quality distribution.

In Table 4-3-4, I leverage information on the selectivity of respondents' upper secondary school in CHIP2002 and CHIP2013 to run identical multinomial probit models. For Model

6 using data from 2002, negative and significant coefficients in "Beta" column on rows five and seven of Table 4-3-4 suggest that respondents who attended a selective "National & Key" or "Municipal & County Key" upper secondary school are more likely to be a teacher than to be working in private or public sector, compared to those who attended "Non-Key & Other" schools. However, for public sector jobs, "Beta" column results in rows nine and eleven indicate that those who attended the most selective "National & Key" schools were not statistically more likely to choose teaching. On the other hand, it is more likely for those who attended less selective "Municipal & County Key" schools to choose teaching over public sector careers. For 2013, results in the "Beta" columns show that individuals who attended selective schools were not more likely to choose teaching than either private or public sector jobs. However, those who attended more selective "Municipal & County Key" schools were more likely to choose teaching rather than private or public sector jobs. Moreover, while in year 2002, individuals who attended more selective schools are 9 percent more likely to become teachers than to work in other sectors, comparing the "M Effect" column results in rows one and three for Model 6 and 7 shows that those who attended more selective schools are becoming less likely to choose the teaching sector. To this end, by 2013, the numbers have become statistically insignificant for those who attended the most selective "National & Provincial Key" schools. In other words, compared to 2002, individuals who attended the most selective schools are no longer more likely to choose teaching careers in 2013.

Similarly, in Table 4-3-5, I report multinomial probit regression results that relate individuals' performance on National College Entrance Exam (*gaokao*) to their career choices: teaching, private or public sector jobs. In Models 8 and 9, exam scores are standardized within exam year, and exam type dummies controlling for Arts, Humanities, and Science tracks are added as measures to mitigate inter-temporal and inter-subject influence. Although exam scores information is only available in more recent waves of CHIP2007 and CHIP2013, the likelihood of entry into teaching relative to other careers for high scorers on the National College Entrance Exam is declining, which seems to be consistent with prior results using educational attainment and school selectivity information. In particular, results found in rows three and five in the “Beta” columns for Model 8 and 9 suggest that it was more likely for higher-scoring individuals to choose teaching over private sector jobs in 2007, but in 2013 the advantage dissipates and becomes statically insignificant. To add, the “M. Effect” columns reflect Adjusted Predictions at the Means (APM), based on estimating the marginal effect of increasing exam scores by 1 standard deviation on the likelihood of choosing private or private sector jobs over teaching careers. A comparison of APM results between Models 8 and 9 from row one in the “M. Effect” columns suggest that a lower probability of choosing teaching jobs are also predicted for individuals who score around the mean on the National College Entrance Exam, which was approximately 469 and 466 respectively in the 2007 and 2013 subsample.

Finally, as a note of caution, the decline in probability for higher aptitude individuals to enter teaching careers may be attributed to two different forces, one being that high-ability individuals in younger cohorts are disproportionately choosing non-teaching careers, and another explanation being high-ability individuals among older workers are electing to leave teaching posts. Unfortunately in this section, due to data limitation, it is not possible to untangle the influence and evaluate how magnitudes of these two factors compare. However, the above analysis can confirm that by utilizing observed career decisions to approximate individuals' revealed occupational preference, I find that the relative attractiveness of becoming a teacher, relative to private sector professional jobs, have declined substantially for more educated and higher ability individuals. Relating the results in this section to that of Part II, the timing of the decline of teaching career's relative attractiveness coincide with the occurrence of lower returns to education and human capital for teachers, as compared to the private sector. Importantly, this finding is in large part consistent with the broader literature on teacher occupational choice in developed countries, which has found that large declines in the relative aptitude of teachers are observed when outside employment opportunities become ample and more resourceful.

Table 4-3-4. ***Multinomial Probit Regression Results of the Relationship between Upper Secondary School Selectivity and Career Decision Outcomes ("Teacher" as omitted base category), by year***

	Year	Model (6) 2002		Model (7) 2013	
Career Outcomes	(Ref = AA's)	Beta	M. Effect	Beta	M. Effect
Omitted: Teacher	National & Key	-	0.093*	-	0.014
		-	(0.044)	-	(0.048)
	Municipal & County Key	-	0.094*	-	0.062*
		-	(0.024)	-	(0.030)
Private Non-teaching	National & Key	-0.418*	-0.072	-0.156	-0.055
		(0.169)	(0.050)	(0.259)	(0.057)
	Municipal & County Key	-0.489*	0.107*	-0.354*	-0.073*
		(0.107)	(0.023)	(0.151)	(0.033)
Public Non-teaching	National & Key	-0.341	-0.021	0.072	0.041
		(0.274)	(0.062)	(0.206)	(0.038)
	Municipal & County Key	-0.252*	0.013	-0.180	0.011
		(0.108)	(0.021)	(0.143)	(0.026)
	Control Covariates	Yes		Yes	
	Number of Observations	1864		1763	
	Number of Teacher Observations	466		388	
	Percent Teachers	0.25		0.22	

Note: Robust standard errors in parenthesis and are clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10. Control covariates include respondent’s sex, age, quadratic age, minority status, party membership status, permanent contract status. Marginal effects (dy/dx) and associated robust standard errors (in parenthesis) are calculated based on delta-method.

Table 4-3-5. ***Multinomial Probit Regression Results of the Relationship between National College Exam Score and Career Decision Outcomes ("Teacher" as omitted base category), with Marginal Effects***

		Model (8)		Model (9)	
		2007		2013	
		Beta	M. Effect	Beta	M. Effect
Omitted: Teacher	College Entrance	-	0.042*	-	0.036*
	Exam Score (sd)	-	(0.017)	-	(0.016)
Private Non-teaching	College Entrance	-0.309*	-0.070*	-0.115	-0.003
	Exam Score (sd)	(0.094)	(0.024)	(0.078)	(0.023)
Public Non-teaching	College Entrance	-0.122	0.027	-0.210*	-0.033#
	Exam Score (sd)	(0.095)	(0.021)	(0.075)	(0.018)
	Control Covariates	Yes		Yes	
	Exam Type Dummies	Yes		Yes	
	Number of Observations	668		1005	
	Number of Teacher Observations	112		249	
	Percent Teachers	0.17		0.25	

Note: Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10. Marginal effects columns report standard errors based on delta-method. National college exam scores are standardized within exam year.

4.4 Results for Part IV:

Teacher Exits, Opportunity Wages, and Non-Pecuniary Outcomes

In this section of the dissertation, I attempt to understand why teachers leave teaching and draw connections between wage characteristics, occupational choice, and non-pecuniary outcomes. I take advantage of the panel structure of the RUMiC urban subsample, which matched individuals' employment information between years 2007 and 2008. More concretely, I track teacher's job status across years to examine the prevalence of teacher turnover, identify teacher job switch destinations, and relate these decisions to observed wage characteristics. In addition, I conduct explorative investigation on how teacher's attained utility, as approximated by a composite index assessing subjective well-being, may be affected by one's career switching behavior. In the following paragraphs, I first describe the unique matched-teacher panel data, and detailed results obtained in this section.

As described in the data section, RUMiC 2007 and 2008 are two special waves of CHIP dataset that could be linked together to produce a matched panel that tracks households so long as they are present in the surveyed cities. Leveraging this sample feature, I first match all individuals in both waves of the urban subsample using their exclusive personal identifiers, which resulted in a combined dataset with 5,825 tracked individuals across the two waves. Next, I identify teachers according to sectoral, occupational, and work unit ownership information, such that teachers are defined as professional workers who are employed in the education sector and working in public institutions (*shiye danwei*). Unfortunately, due to data availability, I am not able to distinguish between levels of instruction. Altogether, across two waves of data, I find a total of 211 tracked teachers, whose labor market information is present in both RUMiC 2007 and 2008. One important caveat and limitation of relying on RUMiC's household-based resampling approach to identify teacher career choices in the follow-up survey, is that I am not able to fully track new entrant teachers, especially if they are fresh graduates or new participants in the labor market. For instance, all but 2 individuals among 39 new entrant teachers held prior administrative jobs in the education sector. Therefore, new entrants I track in this analysis are exclusively not first-time workers, which I roughly estimate to account for at least 75 percent of all teachers in the follow-up survey, while the remaining share of all teachers are new labor market entrants.

As illustrated in Table 4-4-1, I provide summary statistics on variables of interest in this analysis by survey year, as well as differences between waves and the corresponding t-statistics. Importantly, there are a total of 211 matched teachers that are tracked across both years. In 2007, there are a total of 172 tracked teachers; among them, 107 remained as teachers in 2008, 65 left their original teaching posts. In 2008, 39 new entrants enter into teaching posts to replenish the teacher sample to a total of 146 matched individuals. In terms of background characteristics across the two sample years, the only statically significant difference is log weekly wages: the average in 2007 is about 0.10 log points lower than in 2008 (approximately 10 percent), which reflects both a nominal year-over-year wage increase and any potential compositional changes related to career choices sets. All other key variables do not show substantial variation across the two waves.

To begin, the first segment of the current analysis focuses on understanding alternative job destinations for teachers. Using treemapping illustration shown in Figure 4-4-1, I offer visual representation of the occupational destinations of all 172 baseline identified teachers, as observed in the follow-up survey a year later in 2008. To be clear, I define teachers who work in the basic education as professional workers who are employed in the education sector and working in a public institution (*shiye danwei*), which is consistent with previous sections. Figure 4-4-1 captures the job destination information of teachers in 2008, and observations can be grouped in three main career choice categories: remained as teachers (111 teachers, or 64 percent of 172 baseline identified teachers), job change within education sector (33 teachers, or 19 percent), job change out of education sector (28 teachers, or 16 percent). To this end, it is worth noting that teacher turnover rates are high at over 30 percent, and only about two-thirds of teachers in 2007 remained in a public school teaching career in the following year (represented by darkest shade in Figure 4-4-1). After a detailed review of the teacher turnover literature, I am not aware of any existing research that provides turnover rates using a tracked panel approach in China, so these estimates presented here contribute substantively to the current understanding on the prevalence and magnitude of teacher departures from teaching posts and the education sector as a whole in the Chinese context.

In terms of departures from teaching, it is interesting to find that about one-in-five (19 percent) of teachers left teaching positions but remained in the broader education sector, and are found working in administrative positions (10 percent), school principals (5 percent), or transitioned to teaching positions in non-public schools (4 percent). These types of job switching can be broadly interpreted as career progression, which may result in promotion or expansion of existing responsibilities on-the-job and may be productivity enhancing for the education sector. Among those who exited education sector entirely, the most common destinations are unemployment or retirement, jobs in “Culture, Sports, and Entertainment,” “Health & Social Services,” or “Transportation” sectors. Individuals also departed to work in “Information Technology,” “Finance,” “Personal Services,” “Wholesale & Retail,” but are significantly fewer. These types of sector switching are more concerning because teacher departures to these sectors are likely permanent.

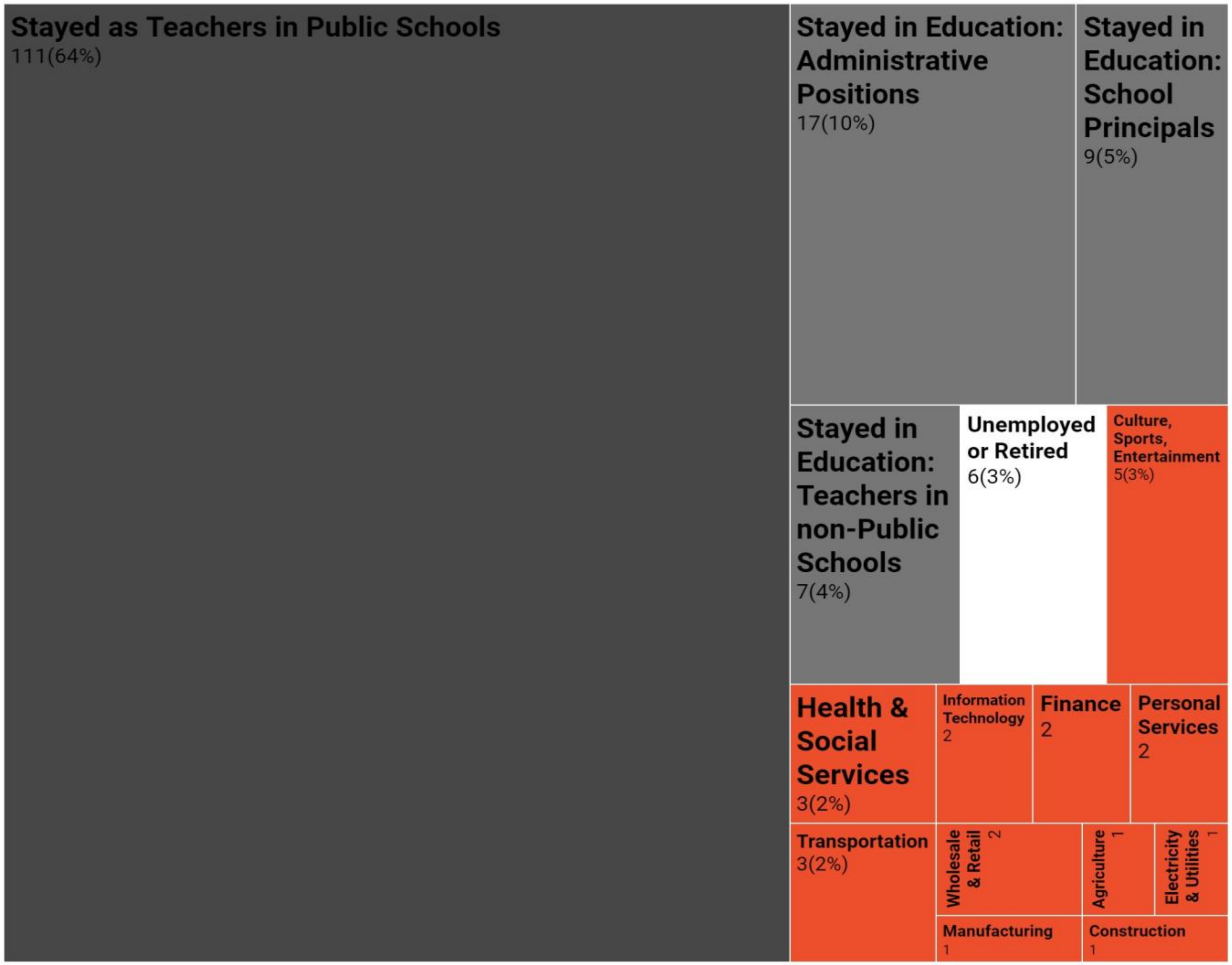
Next, in the second segment of the analysis, I turn to understanding the role of opportunity wages on teacher departures. In more detail, I leverage within-individual variation in exposure to different opportunity wage levels to eliminate unobserved time-invariant heterogeneity that may influence job exit decisions. In Table 4-4-2, I present results from a standard probit model that has a binary dependent variable indicating whether individuals are identified as a teacher (otherwise =0); coefficients are directly interpretable as probability of working as a teacher that is related to each unit increase in the independent explanatory variables. To be clear, the key variable of interests “Distance in Log Points to Comparable Worker Wage” is computed as the conditional wage difference between teacher *i* and comparable workers who resides in the same province, with the same level of educational attainment at time *t*. Model 1 is the base model, while I subsequently add more control variables, and Model 4 contains results from the full specification.

Table 4-4-1. ***Summary Statistics of RUMiC 2007 and 2008 Key Variables (Teachers Only), by year***

		2007			2008			Difference:	t-statistic
Variables	Definitions and Metric	N	Mean	SD	N	Mean	SD	2007-2008	
Teacher Exits	Individuals who were teachers in 2007 but left teaching in 2008 =1, otherwise =0	-	-	-	65	-	-	-	-
New Teacher Entrants	Individuals who were not teachers in 2007 but became teachers in 2008 =1, otherwise =0	-	-	-	39	-	-	-	-
Teacher Remained	Individuals who were teachers in both 2007 and 2008 =1, otherwise =0	-	-	-	107	-	-	-	-
Log Weekly Wage	Log of weekly earnings	211	6.42	0.497	211	6.519	0.465	-0.099	-2.087*
Distance in Log Points to Comparable Worker Wage	Conditional wage difference in log points between each teacher and comparably educated workers who reside in the same province	211	0.444	0.409	211	0.539	0.346	-0.10	-0.255
Log Subjective Well-Being Scale	Log of Subjective Well-Being Composite Score based on 12 Questions (GHQ-12)	129	3.354	0.155	129	3.35	0.154	0	0.030

Weekly Work Hours	Number of working hours per week	211	40.476	9.001	211	40.099	8.945	0.377	0.425
Health Status		211			211				
Excellent	Respondent's self-assessment of relative health status compared to others of similar age	-	0.232	-	-	0.142	-	0.09	-
Good		-	0.488	-	-	0.54	-	-0.052	-
Average		-	0.27	-	-	0.289	-	-0.019	-
Poor		-	0.009	-	-	0.028	-	-0.019	-
Female	Female =1, male =0	211	0.507	-	211	0.517	-	-0.01	-
Age	Age in Years	211	39.16	8.59	211	40.1	8.4	-0.94	-1.145
Single	Single =1, otherwise =0	211	0.071	-	211	0.066	-	0.005	-
Minority	Minority =1, otherwise =0	211	0.014	-	211	0.014	-	0	-
Permanent Contract	Working on permanent contract or with tenure =1. otherwise =0	211	0.99	-	211	0.985	-	0.005	-

Figure 4-4-1. ***Occupational destinations of RUMiC 2007 teachers, in 2008***



Source: Author’s compilation according to RUMiC 2007 and 2008 tracked teacher subsample.

Importantly, across all models in Table 4-2-2, wage gap between teachers and comparable workers with the same level of educational attainment is shown to have a negative relationship with probability of working as a teacher. In the base model with no additional controls, this relationship is not statistically significant, but once adding important time-variant control variables to improve precision, the negative relationship becomes marginally significant at -0.319 (p-value<0.10) and -0.442 (p-value<0.10) in Models 2 and 4 respectively. To add, I also provide results of Model 3 as reference for the relationship between nominal wage levels and occupational decisions; the relationship is insignificant. For Model 4, while there are some structural multicollinearity concerns regarding the correlation between "Log Weekly Wage" and "Distance in Log Points to Comparable Worker Wage" due to the computation approach, marginally significant results in Model 4 continue to indicate that larger wage gaps are related to reduced probability of working as a teacher. This negative relationship is evaluated at a 1 to -0.442 ratio (p-value<0.10), which means that for every 10 percent increase in the difference in the wage gap between teachers and comparable workers, a 4.42 percent decrease in the probability of individuals working as teachers is observed. The results here should be interpreted with caution as there could be endogeneity issues with why there exist variations in wages gaps between teachers and comparable workers. For instance, the level of opportunity wages that teachers face could be a function of both wage and non-wage factors, including local perception of job prestige, or local supply of teachers. Therefore, in general terms, I interpret the opportunity wage level as a proxy for how much teachers are valued in relation to a comparable worker in a specific geographic locality.

Table 4-4-2. ***Probit Panel Regression Results of the Relationship between Opportunity Wages and Career Decision Outcomes (Teachers Only)***

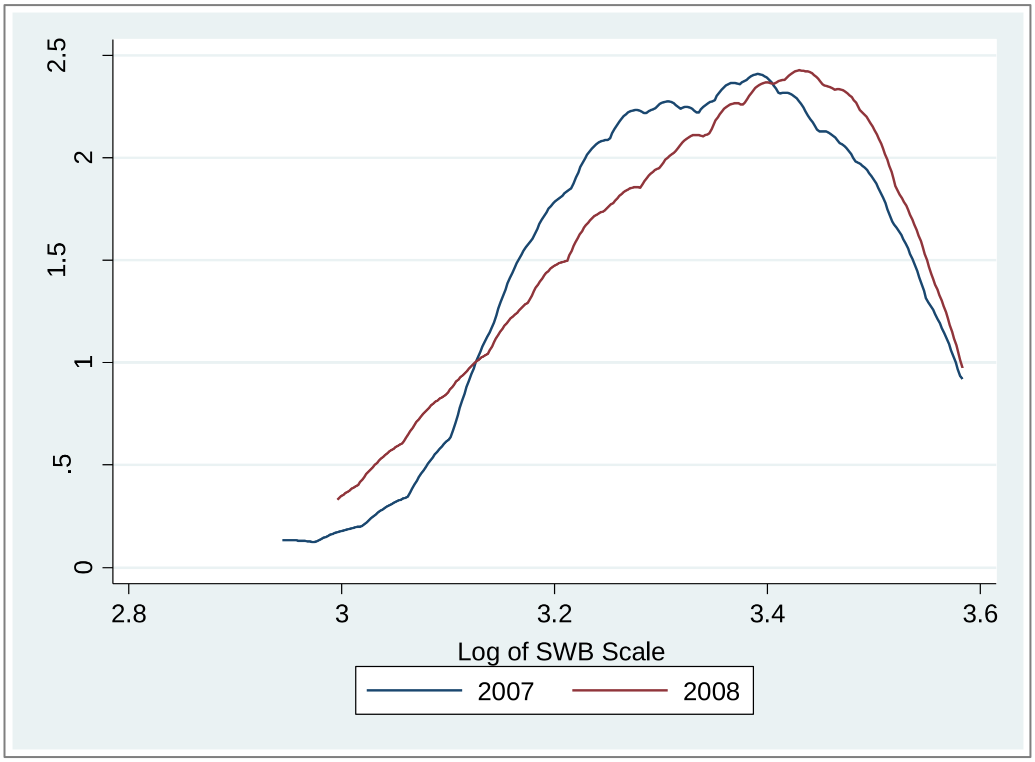
DV: Occupation = Teacher	Model 1	Model 2	Model 3	Model 4
Distance in Log Points to	-0.257	-0.319#		-0.442#
Comparable Worker Wage	(0.182)	(0.188)		(0.259)
Log Weekly Wage			-0.096	0.138
			(0.0143)	(0.199)
Weekly Work Hours		-0.006	-0.006	-0.006
		(0.008)	(0.008)	(0.008)
Permanent Contract Dummy	No	Yes	Yes	Yes
Year Fixed-effect Dummy	No	Yes	Yes	Yes
Constant	0.767*	0.096	0.757	-0.744
	(0.070)	(0.680)	(1.071)	(1.389)
Number of Observations	422	422	422	422
Number of Groups	211	211	211	211

Note: Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10.

In the final analysis presented in Part IV, I relate teacher's job-switching behavior to her general happiness and wellbeing, which I approximate as individual's attained utility. To achieve this, I utilize the subjective well-being (SWB) index to derive one's attained utility. Figure 4-4-2 plots the kernel density distribution of the logarithm of SWB scale for teachers in 2007 and 2008. It is visible that the distributions of SWB scores are similar across both waves and seem to be somewhat left-skewed, which is consistent with the broader literature on general happiness and subjective well-being (Fang, 2017).

In Table 4-4-3, I present results from the panel regression model I fit on the tracked teacher data, which relates within-individual variation in career decisions to their assessment of life's general happiness. To begin, Model 5 is the base model with only career choice indicators, for which indicate the difference in the logarithm of SWB index between each career decision type and the default option of remaining in the job position. In Model 6, I add time-variant control variables such as wage levels, work hours and health status, and the signs of coefficients on all three career decision indicator variables continue to hold. In particular, new entrant teachers report a 5.7 percent gain (p-value<0.10) on the subjective well-being index than in their prior jobs, and this relationship is marginally significant. As indicated by the sign of coefficients, teacher exits within education may be positively associated subjective well-being while the converse is true for teacher departures for non-education sectors, but both are not statistically significant. To further nuance explorative findings obtained in this exercise, it should be cautioned that sample sizes are relatively small and insufficiently powered to detect small differences, and further, not all identified teachers in the sample completed the subjective well-being assessment, and therefore the results presented above can be partially influenced by missing data for almost half of the tracked teacher sample.

Figure 4-4-2. ***Distribution of Log of Teacher's SWB Scores in 2007 and 2008***



Source: Author's compilation according to RUMiC 2007 and 2008 tracked teacher subsample. Kernel density is computed using Epanechnikov method, bandwidth for 2007 is 0.0532, bandwidth for 2008 is 0.0524.

Table 4-4-3. ***Panel Regression Results of the Relationship between Career Decision and Subjective Well-Being (Teachers Only)***

DV: Log of SWB Index	Model 5	Model 6
Career Decisions		
(ref= individual's prior occupational choice)		
Teacher Departures within Education	0.014	0.027
	(0.035)	(0.038)
Teacher Departures to outside Education	-0.10	-0.019
	(0.036)	(0.047)
New Teacher Entrants	0.048	0.057#
	(0.030)	(0.033)
Log of Weekly Wage Control	No	Yes
Number of Work Hours Per Week Control	No	Yes
Health Status Dummies	No	Yes
Permanent Contract Dummy	No	Yes
Year Fixed-effect Dummy	No	Yes
Constant	3.350*	3.363*
	(0.013)	(0.162)
Number of Observations	258	258
Number of Groups	129	129

Note: Robust standard errors in parenthesis and clustered at the provincial-level, * denotes p-value <.05, # denotes p-value <.10.

Chapter V

CONCLUSION AND DISCUSSION

China's rapid economic growth in past decades has created huge employment opportunities and substantially improved general welfare of its population. However, in light of such drastic shifts in the labor market, concerns are raised in this dissertation regarding the potentially large adverse effects of holding teacher wages back from broader market levels; teachers set the standards for the quality of an educational system. Much of the current research on teacher occupational choice, especially in developed economies, has shown that in doing so there are considerable consequences, both in terms of declining teacher aptitude and unrealized student learning. Using a four-part analytic approach in this dissertation, I confirm empirical observations made elsewhere and contextualize theoretical stipulations of the broader occupational choice framework using the case of Chinese teachers. To define the Chinese case and situate this dissertation more closely with the large bodies of education development literature on teacher shortage, recruitment and retention, I have aimed to produce a targeted collection of "thick description" (Steiner-Khamsi, 2016b, p.691) in addition to empirical findings to extend the current state of knowledge on teacher occupational choice and its relevant consequences on student learning, with particular attention to developing contexts.

At the outset of the analysis, I observe two important trends at the aggregate level. On the one hand, average teacher salary has considerably lacked behind that of other sectors, growing at about half the rate of the national mean. Of note, the rate of teacher wage growth varied substantially across geographical regions. On the other hand, the percent of workers with advanced tertiary education degrees are the highest in the education sector than in all other sectors, and educational attainment of teachers was shown to have increased at all instructional levels. However, there are signs of more attractive sectors in recent years that are also competing for workers with advanced degrees, such as “Finance and Banking,” “Information Technology,” and “Public Health and Social Welfare.” Zooming in further on compositional shifts in the teaching force, I find that new entrants are a major source of teacher additions at all instructional levels; however, in lower secondary schools, there is considerable numbers of net transfers out of teaching jobs. In general terms, while wage growth has been largely stagnant for teachers, there is still an increase in the number of individuals with advanced educational attainment becoming teachers, but recent rates of recruitment has been growing comparatively faster in non-education sectors. To be clear, these macro-level findings, while instructive, are aggregate trend summaries of high abstraction and prompts further investigation using micro-level analysis.

Main Findings and Discussion for Part I

Undeniably, teacher quality has been shown to be one of the most important school-related factors in influencing a student’s academic performance. In this regard, policymakers have often relied on pre-labor market human capital signals to screen teacher candidates for potential instructional effectiveness. To establish the causal link between teachers’ comparable and observable quality characteristics and student learning outcomes, in Part I of this dissertation I employed a student fixed-effect strategy to relate differences in teacher characteristics across subjects to variations on student test scores. The results illustrate that student-learning benefits from having a teacher with advanced tertiary degree are evaluated at 0.033 standard deviations. In other words, the learning gains from having a more educated teacher are approximately 1 additional month of learning in a typical 9-month academic year, even after controlling for other teacher background attributes. Further robustness check was conducted by limiting the analysis to only students who have not been systematically sorted according to ability grouping, and the impacts are shown to double, at about 0.071 standard deviations. In examining potential heterogeneous effects, findings suggest that students from advantaged and disadvantaged students both benefit from better educated teachers alike, and there are no foreseeable equity concerns.

Altogether, results presented in Part I of this dissertation underscore the critical consequence teachers can have on students' learning outcomes. In this regard, findings from the Chinese context contribute rigorous evidence to a broader debate in the teacher effectiveness and teacher value-added literature on whether teacher observational characteristics on preparation and certification are useful for improving student learning (Darling-Hammond, 2000; Hanushek & Rivkin, 2006; Harris & Sass, 2007; Winters, Dixon, Greene, 2012). One of the most influential research on this topic in the United States, by Hanushek and Rivkin (2006), found that only 29 percent of all 170 estimates regarding the impact of teacher's earning an advanced degree on student achievement is significant, the vast majority of the impacts are statistically insignificant. This result and others following it have put in question policy efforts that aim at improving teacher education programs or job attractiveness to highly educated individuals, since teacher's human capital levels are poor predictors of teaching effectiveness.

Other studies, however, have challenged these beliefs and confirm that what teachers know, how well they are prepared to teach, and the level of educationally important credentials they hold really do affect student learning (Polk, 2006; Clotfelter, Ladd, & Vigdor, 2007; Hairrel, Rupley, Edmonds, Larsen, Simmons, Wilson & Vaughn, 2011; Meroni, Vera-Toscano, & Costa, 2015; Cakır & Bichelmeyer, 2016). For instance, Jackson and Bruegmann (2009) summarize teacher's observable pre-labor market traits (i.e. licensure, score of license exams, certification, and degree level) in to a single index and find positive associations between observable teacher characteristics and students' math and reading scores. Importantly, classroom teaching is a complex and intellectually demanding activity that requires teachers to possess substantive cognitive, non-cognitive, and critical thinking skills as well as a solid foundation of subject and pedagogical knowledge (Stronge, 2018). To conclude, results in Part I of this dissertation supports this view that teacher's attained human capital levels have serious consequences for improving student achievement, such that more educated teachers can lead to better student learning.

Main Findings and Discussion for Part II

Having established the importance of high ability teachers on effective student achievement, my analysis proceeded to examine the wage returns to common human capital traits – educational attainment level. Accordingly, in Part II, I estimate a Mincer earnings function to examine gaps in mean wage levels and returns to human capital between teaching and non-teaching sectors. In general terms, I find sharp shifts in the relative attractiveness of wage characteristics in the teaching sector. I find that in 1998, teachers' mean wage was 13 percent higher than workers in non-teaching private sectors, but this advantage has since disappeared in 2007, and by 2013, the mean wage reversed to be in favor of workers in non-teaching sectors by 11 percent, marking a total of 24 percentage point reversal. Regarding gaps in returns to education, returns to having a Bachelor's degree or above became significantly higher, about 11-15 percent, in private non-teaching sectors than the teaching sector in years 2007, 2008, and 2013. Connecting both findings, it is suggested that the education sector has made potentially large salary savings compared to if it was required to hire individuals with similar qualifications at the market rate. To this end, prolonged lag in mean wage growth and returns to human capital may be critical risk factors for thwarting potential high quality candidates from entry.

As observed in the United States and elsewhere, relative wage levels are strong occupational determinants, and may substantially influence career decisions of prospective teacher candidates. Recent evidence linking career aspirations of 15-year-olds and current teacher salary levels show that students in the top tertile of academic achievement who live in countries that pay their teachers better are more likely to aspire to become a teacher, relative to countries that pay teachers poorly (Park & Byun, 2015). Consistent with studies that examine the relationship between salary and career inclinations for teacher education enrollees (Watt & Richardson, 2012) and recent college graduates (Bacolod, 2007), findings from this section provide insights to future trajectories of who will become teachers. In sum, the consequences of withholding teacher salary levels could be longstanding, and the stake for leaving teaching as an unattractive career is potentially high and the timeline to alter the decline teacher wage trend is pressing.

Main Findings and Discussion for Part III

In Part III, I proceed to address the empirical question of how teacher quality has changed with respect to the shifting landscape of China's job market. To achieve this, I apply multinomial probit regression to assess the relationship between human capital measures, such as educational attainment level, high school selectivity, and national college entrance exam scores, on individual's occupational choice. Notably, findings show that while individuals with advanced tertiary degrees are consistently more likely to choose teaching as a career, this relationship is considerably weaker among younger cohorts in recent years. For one, between 1988 and 2013, more educated individuals with Bachelor's degrees or above are consistently more likely to choose teaching over both private and public non-teaching sectors. For another, by separately calculating adjusted probabilities of choosing teaching careers for individuals aged 30 and 50 years old, I find that in 2007 and 2013, new labor market entrants with advanced tertiary degrees are 4.7 percent and 5.8 percent less likely than comparable workers in older cohorts to choose teaching.

To confirm the validity of these findings, I perform additional analyses by substituting educational attainment with upper secondary school selectivity and national college entrance exam scores as proxies for human capital and worker aptitude. Findings indicate that graduates from the most selective secondary schools and those that scored better on the national college entrance exam were more likely to enter the teaching sector in 2002 and 2007, respectively. However, by 2013, workers in both high aptitude groups became no more likely to choose teaching over private sector jobs. Altogether, these findings suggest that workers with better labor market signals or human capital traits have become less likely to enter the education sector, resulting in relative declines in teacher quality.

A broad class of existing studies has examined the positive relationship between earnings and career attractiveness, and have documented the relative declines in teacher aptitude, qualifications, and skills (Vegas, Murnane, & Willett, 2001; Elfers, Plecki, John & Wedel, 2008; Gilpin, 2012). In particular, Hoxby and Leigh (2004) has shown that the share of teachers coming from the most elite colleges have fallen over time in the United States; Fredriksson and Ockert (2008) find similar patterns in Sweden that younger cohorts are much less likely to choose a career in teaching. Using the case of Chinese teachers, I add to this large and growing literature that document the worrisome trend in relative declines in teacher aptitude and ability in relation to other sectors.

Main Findings and Discussion for Part IV

In Part IV, I leverage the availability of a nationally representative panel data containing 211 matched teachers with information on their employment information, and track their career destinations across time. In general, I find that teacher turnover rates are relatively high, and there exists positive associations with the level of opportunity wages, and there is no obvious evidence on individual non-pecuniary gains from teacher exit decisions. For one, findings show that teacher turnover rates are high and evaluated at approximately 35 percent, of which about half of the teachers exit the sector entirely. The top outside-education career destinations for teacher exits are “Culture, Sports, and Entertainment,” “Health & Social Services,” or “Transportation” sectors. Importantly, these findings contribute substantively to the current understanding in China on the prevalence and magnitude of teacher departures from teaching posts and the education sector. For another, I evaluate the degree to which opportunity wage levels influence teacher turnover decisions, I find that every 10 percent increase in opportunity wages that teachers face, it is shown to be 4.42 percent less likely to remain a teacher. In general terms, I interpret the opportunity wage level as a proxy for how much teachers are valued in relation to a comparable worker in a specific geographic locality. Therefore, the less value a community has for teachers, the higher the likelihood of teacher turnover. Finally, I conduct an explorative analysis on whether there are non-pecuniary benefits for those who leave teaching, and there is no evidence to suggest that there exist substantive differences on non-pecuniary benefits to teacher job switching.

The issue of teacher turnover is a crucial component of occupational choice and holds the key in broader retention efforts. In particular, Chingos and West (2009) have shown that more effective teachers are more likely to receive higher pay when they depart from education, but do not when they remain as teachers. Other scholars have examined the importance of non-pecuniary factors, such as working conditions and workload, and stipulate that they are also important for teacher retention (Ingersoll, 2003; Guarino, Santibanez, & Daley, 2006). Accordingly, findings in this dissertation provide some new evidence on alternative careers, opportunity wages, and non-pecuniary effects of teacher turnover that are more consistent with existing studies which have highlighted the intertwined relationship between pecuniary and non-pecuniary factors on teacher occupational choice (Han, Borgonovi, & Guerriero, 2018). As such future research is still needed to untangle the overlay between wage levels and social prestige, among other occupationally important non-pecuniary factors.

Policy Implications

As China continues to modernize its education system and address equity concerns in its education development, findings presented in this dissertation point to several important policy considerations regarding existing teacher recruitment and retention policies and practices. Most strikingly, the analysis gathered evidence in underscoring the consequences of holding teacher wage levels back, which affects teacher occupational choice, instructional quality, and student learning outcomes.

As shown in Part I, the student achievement gains from having more capable teachers are non-trivial and can be reasonably expected to compound over the course of a student's learning career. In particular, there may be substantial returns to boosting ability traits of teachers, in the form of increased student learning, especially in settings where current levels of teacher staffing and quality is low. The findings presented here resonate with the broader national policy focus and discussion on setting teacher quality improvement as a primary objective in the "Thirteen-Five" period before 2020 (State Council, 2017, Section 4). In particular, as shown in Part I, boosting teacher quality by recruiting better qualified teachers can lead to close to 10 percent gain in the average learning productivity over the course of a typical school year (1 month of additional learning in a typical 9-month academic year). Therefore, evidence gathered in this study supports the current Chinese national policy focal point on placing a strong emphasis on boosting teacher quality; policy makers should continue to realize their commitment to realizing meaningful teacher quality improvements.

In addition, Parts II and III have indicated the important relationship between relative wage characteristics and teacher occupational choice. The conclusion is straightforward: wage policies for teachers need to include meaningful considerations for the concurrent wage conditions and developments in the broader labor market, which have been shown to be crucial covarying factor influencing teacher occupational choice. In recent years in particular, younger cohorts of highly educated workers are becoming less likely to choose teaching as a career, which coincides with the rapidly decreasing returns to education/skills within the education sector. This may be a worrying from a policy standpoint, if current developments are left unattended, because there considerable consequences, both affecting the status of the teaching profession as well as influencing the level of student learning achieved. To this end, policy makers should rethink existing forms of teacher compensation arrangements and develop sustainable wage adjustment practices, especially in relation to conditions in the broader market levels, in order to retain and attract bright minds to enter and stay in teaching.

Limitations and Paths for Future Research

It is worth noting that while the methodology and findings from this dissertation are rigorous to the extent possible, interpretation of results require further caution with special attention to remaining issues not fully addressed in this current study. First, due to data limitations, the current study is confined within urban China and does not address the vast differences that exist between urban and rural schools in China. In this vein, the complications in teacher quality and occupational choice that arise as result of large geographic variabilities cannot be overlooked. As previous studies have illustrated, living and working conditions are reasonably expected to influence teacher occupational decisions through compensating wage differentials, which are important factors in individuals' career determination. Therefore, further research on the link between teacher occupational choice, instructional quality and student learning is needed.

Second, findings illustrated in Parts II and III are to be contextualized in relation to the broader trajectory of development of tertiary education in China. Importantly, tertiary education enrollment doubled in 1999/2000 as a result of China's Higher Education Expansion reform, which was designed as a counter-cyclical stimulus measure to delay entry of new labor supply, in response to the 1997/1998 Asian financial crisis that resulted in export contraction and subsequent saturation in the labor market (Che & Zhang, 2017). By June 2000, the Ministry of Education announced that the enrollment expansion target had increased to 1.56 million students, or a 44 percent gain year-over-year, which was observed somewhat evenly across fields and disciplines (Che & Zhang, 2017). To this end, the rapid expansion of tertiary enrolment implies that the meaning of being "tertiary-educated" has changed dramatically for new labor market entrants, as tertiary education becomes in abundant supply in the post reform era, which may both impact labor prices and quality. Therefore, the interpretation wage differential and entry probability results in Part II and III, for the post-2003/2004 period require additional caution because this is when graduates who are affected by the enrolment expansion enter the job market. Future research in this area is needed to understand how teacher quality and occupational choice is affected by educational reforms from both labor supply and demand sides.

Third, there may be concerns regarding the relatively small teacher-panel sample used in Part IV, which limits its national representativeness and interpretation of the associated results. To this end, if more data becomes publicly available, a longer panel could be readily constructed to extend the current analysis and verify the generalizability of results. Finally, this dissertation conceptualizes teacher quality using both teacher input and output proxies. For teacher output proxies, I utilized student achievement scores on three tested subjects. Notwithstanding, there are arguably many other educationally-important teacher outputs that is not fully captured in testing, such as non-cognitive skills development, therefore this limitation highlights a need to examine these types of learning outcomes in future research.

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